Section Four
Hazard Identification and Profiles

Contents of this Section

4.1 IFR Requirements for Hazard Identification and Profiles

Requirement §201.4(c)(2) of the IFR states that "[the State plan must include a risk assessment] that provides the factual basis for activities proposed in the strategy portion of the mitigation plan." The IFR includes two specific requirements for identifying and profiling natural hazards:

- **Hazard Identification** per **Requirement §201.4(c)(2)(i): "**[The State risk assessment shall include an] overview of the type … of all natural hazards that can affect the State …."
- **Hazard Profiles** per **Requirement §201.4(c)(2)(i)**: "[The State risk assessment shall include an overview of the] location of all natural hazards that can affect the State, including information on previous occurrences of hazard events, as well as the probability of future hazard events, using maps where appropriate …"

4.2 Environment

Political Divisions

Louisiana had been governed under 10 different flags since the 1500's before being admitted to the union in 1812. The major political sub-unit in the State is the parish, of which there are 64 (see Map 4-1). Section Five and Appendix E of this Plan includes information about relevant aspects of the demographics of the State and the parishes. The remainder of this subsection describes the physical geography and climate of the State.

Physical Geography

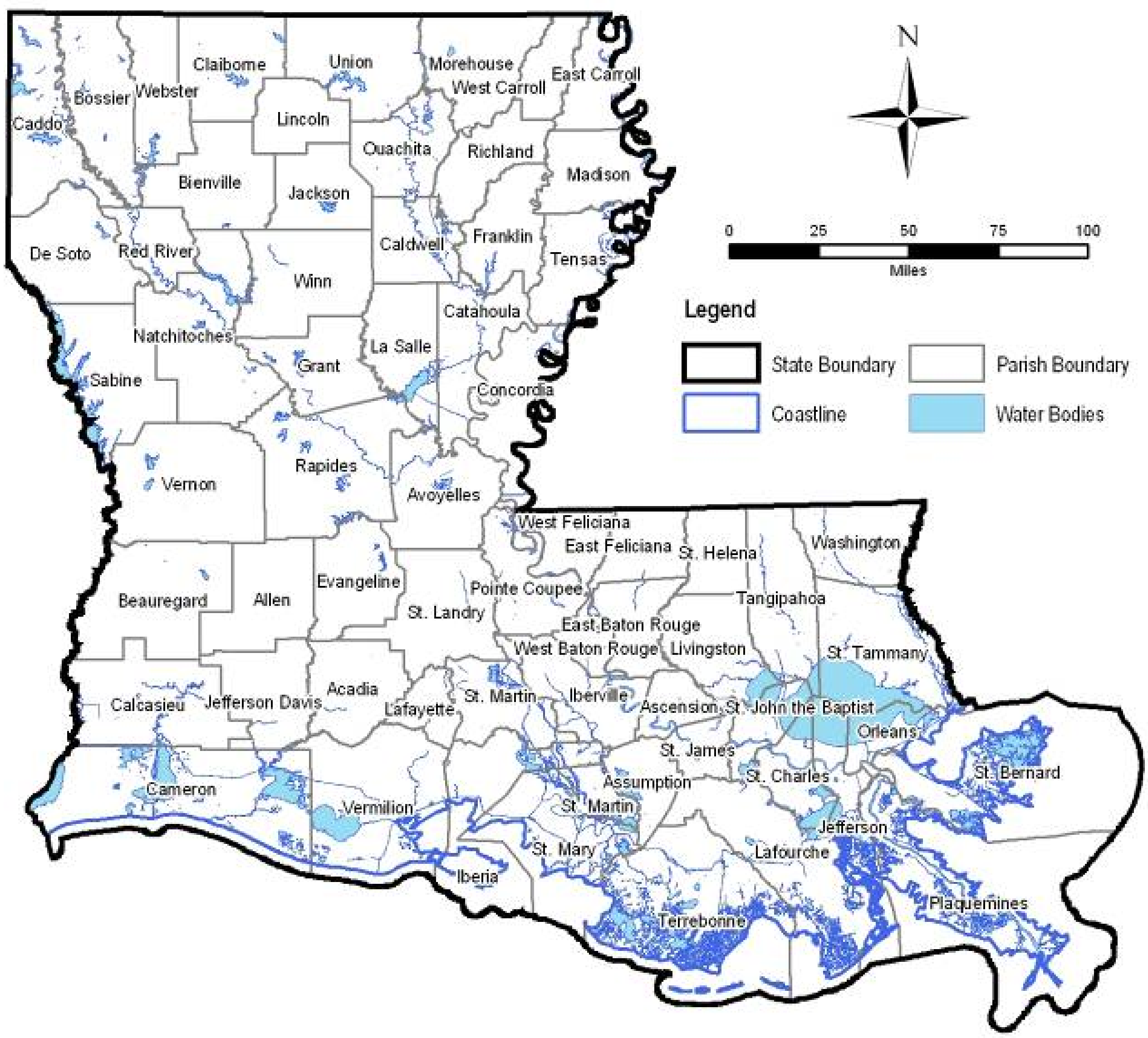
Louisiana is situated entirely within the southern margin of the physiographic region of the United States that is referred to as the Gulf Coastal Plain and relief is relatively slight across the State. Although not always distinct, there is a series of low ridges and valleys paralleling the coast that divide the State into three major physiographic regions: hills, terraces, and lowlands.

Hills

Local elevations north of the 31st Parallel are some of the highest in Louisiana. This region, occupying the area north and west of a line running from Leesville to Jena to Monroe, contains the oldest rocks in the State. Valleys of local streams in this zone (except for the 10- to 15-mile-wide Red River Valley) are sufficiently narrow so that roads and settlements are located on the divides rising between the river valleys.

Two "ranges" of small hills are noticeable within the region, primarily because they are composed of erosion-resistant sandstone: the Kisatchi Uplands on the southern margin; and the Nacogdoches Uplands, which are 30 to 50 miles further inland. The highest point in the State, Mount Driskill, rises 535 feet within the Nacogdoches Uplands.

Map 4-1: State of Louisiana



Terraces

The terraces, along with the lowlands, are geomorphic features formed during relatively recent geologic times. They represent former river floodplains or coastal areas that have been raised above the present floodplains between periods of glacial advances. As the glaciers far to the north of Louisiana melted, sea level rose, causing streams to slope more gently than before. This resulted in slower stream velocity and greater deposition of sediments that built terraces. Four major terraces (corresponding to the five major glacial advances of the past two million years) have formed like steps rising up from the Gulf of Mexico. The terraces are areas in which the land gradually rises to counterbalance the sinking of the deltaic area south of the terraces at the Coastal Hinge Line.

Louisiana terraces are found in two major areas. The first zone extends through the Florida parishes, except for a narrow portion of East Baton Rouge Parish south of Baton Rouge where the Mississippi floodplain encroaches eastward; and the extreme southern portions of Livingston, Tangipahoa, and St. Tammany Parishes bordering Lakes Pontchartrain and Maurepas. The second extensive area of terraces lies west of the Atchafalaya floodplain and south of the Kisatchie region, extending to within approximately 25 miles of the Gulf of Mexico.

Lowlands

The lowlands are comprised of river floodplains and marsh. Relief is very slight in these areas and elevation is low, in some cases below sea level. North of the headwaters of the Atchafalaya, the Mississippi floodplain extends from the Mississippi River to approximately 30 to 70 miles west of the River. In the southern part of Louisiana, the floodplains generally fan out on either side of the Mississippi and Atchafalaya Rivers, encompassing the entire coastal zone. Two rivers primarily generate the floodplains: the Mississippi and Atchafalaya (which combines waters of the Mississippi and Red Rivers). Several other major streams flow out of the Mississippi River in the southern part of the State, including Bayous Lafourche, Plaquemines, and Manchac. However, an extensive levee system along the lower Mississippi River controls flow into these streams. During the past several thousand years, these streams have meandered within the floodplains, creating geomorphic features within the region, including meander scars and oxbow lakes such as the False River north of Baton Rouge. Perhaps the most distinguishing feature of the Mississippi River is its “birdfoot” delta, produced by the deposition of sediments as the river flows into the Gulf of Mexico.

Forested marshlands that extend along the entire coastal sections of the State south of the Coastal Hinge Line can be subdivided into the Chenier Plain (west of Marsh Island) and the Deltaic Plain (east of Marsh Island). Landforms of the Chenier Plain are dominated by the presence of a westward “longshore drift” in the Gulf of Mexico, which has moved Mississippi/Atchafalaya River sediments against the shore to create a broad mud flat. Other features of the Chenier Plain include beaches and ridges running parallel to the coast. The Deltaic Plain is characterized by several systems of old natural levees, which former channels of the Mississippi River created, striking at right angles to the coast. In addition, several barrier islands exist in this part of Louisiana, most notably Grand Isle and the Timbalier, Dernieres, and Chandeleur Island chains.

Climate

Maritime air masses originating over the Gulf of Mexico, coupled with Louisiana’s sub-tropical latitude and minimal elevations, combine to produce the State’s characteristic warm and humid climate. Average annual temperatures range from the mid- to upper-60°s Fahrenheit (F) across the State. Precipitation is well distributed throughout the year, with annual totals ranging from a low of less than 50 inches in the northwestern corner of Louisiana to more than 70 inches in sections of the Florida parishes. Louisiana’s statewide precipitation average of approximately 58 inches is one of the highest totals for any state in the country. Furthermore, annual statewide average precipitation has been above normal during recent years as the last 15 years have been some of the “wettest” of this century.

Louisiana springs (March, April, and May) are highlighted by steadily warming temperatures and frequent rainfall. Spring is a season of pronounced storminess in the State. Surface fronts mark the boundaries between cool, dry, continental air masses from the north and those originating over the Gulf - distinct contact between these air masses promote the potential for violent weather. Spring is also Louisiana’s peak season for severe thunderstorms, which may produce heavy rains, high winds, large hail, lightning and tornadoes. In addition, spring fronts often stall over the State, occasionally producing rainfall totals in excess of 10 inches within a period of a few days. Soils tend to be near-saturation at this time of year and spring typically becomes the period of maximum stream-flow across Louisiana. Collectively, these characteristics increase the potential for high water throughout the State, and low-lying, poorly drained areas are particularly subject to flooding during these months.

Southerly flow of warm and moist air from the Gulf dominates during the summer months (June, July, and August), resulting in a generally consistent climate regime through the middle of the year. Temperatures during this season remain fairly consistent, with average summer temperatures generally in the low 80°s F statewide. Daytime highs generally range from 85° F to 95°F, while overnight lows typically remain in the 70°s F. Passing frontal systems are infrequent during summer, but the steady inflow of moist, unstable Gulf air masses promotes frequent development of showers and thundershowers, particularly across the southern parishes. The State's precipitation gradient is most pronounced at this time of year, with average summer totals increasing from roughly 10 to 12 inches in the northernmost parishes with up to almost 20 inches along the coast. Yet, periods of drought are possible, particularly across the northern tier of parishes, when weak high pressure may inhibit the development of convective showers for days, or even weeks, at a time. Severe weather is also a concern, but events tend to be somewhat less violent and not as widespread as those reported in spring. Summer thunderstorms are capable of producing heavy downpours, with strong winds and large hail, but tornadic activity is greatly diminished compared to springtime, particularly over the southern half of the State. Summer marks the start of the Atlantic tropical cyclone season, however, and Louisiana is susceptible to the impact of systems fueled by the warm waters in the Gulf.

Autumn (September, October, and November) is a period of moderating temperatures and is often considered the best season in Louisiana in terms of outdoor comfort. Although tropical weather activity reaches its peak at this time of year, the duration of such events tends only to be a few days. Also, in the periods between tropical storms, daytime humidity tends to be somewhat lower than other times of the year. And while frontal activity returns to the State during these months, contact between continental and Gulf air masses are minimized, resulting in weak frontal systems, most of which produce little or no rainfall. Ironically, autumn is the "driest" season of the year for Louisiana.

Louisiana winters (December, January, and February) are characterized by a strong thermal gradient across the State, with average seasonal temperatures ranging from the mid-40°s F over northern Louisiana to the low 50°s F across the southern parishes. While seasonal average temperatures remain above freezing statewide, winter is marked by large shifts in daily temperatures associated with passing cold fronts. Cold Canadian air extends through the State and into the Gulf at least once during most winters. Indeed, freezing temperatures are fairly common; only the extreme coastal margins occasionally avoid "Arctic outbreaks" for an entire season. However, these freezing events seldom continue uninterrupted for longer than a week. The vast majority of winter precipitation arrives as rain, but accumulations of snow do occur. Ground-cover is usually modest and of short duration in the northern half of Louisiana, whereas measurable accumulations in the southern half of the State are relatively uncommon. As such, snowfall is not a major concern, but freezing rain and ice storms can create significant problems within the State.

4.3 Hazard Identification

The State of Louisiana has suffered significant losses of lives and property from natural hazards. The State has the fifth most declarations in the United States, with 45 Presidential Disaster Declarations since 1965 (see Table 4-1 below). Hurricanes, floods, and tornadoes, among other hazards, have challenged Louisiana to develop ways to reduce future damages from hazards.

Table 4-1: Disaster History 1965 - 2004

Declaration Details			Type of Assistance (# of Parishes)[13]		
DR Number	Date	Type	Individual (IA)	Public (PA)	Both IA & PA
208	09.10.65	H	-	-	53
272	08.18.69	H	-	-	5
315	10.13.72	H	-	-	21
374	04.27.73	SS, F	-	-	38
418	02.23.74	F	-	-	6
448	09.23.74	H	-	-	10
450	11.01.74	SS	-	-	1
3011	04.09.75	H, R, F	-	-	7

[13] Individual Assistance (IA) and Public Assistance (PA) are disaster relief programs administered by FEMA and are defined in more detail in Appendix A.2.

Declaration Details			Type of Assistance (# of Parishes)[13]		
DR Number	Date	Type	Individual (IA)	Public (PA)	Both IA & PA
470	05.19.75	H, R, T	-	-	12
3031	01.31.77	D, F	-	-	34
534	05.02.77	SS, F	-	-	8
556	05.09.78	SS, F	-	-	4
565	09.20.78	SS, F	-	-	2
567	12.06.78	SS, T	-	-	2
584	05.02.79	SS, F	-	-	10
604	09.25.79	SS, F	-	-	3
616	04.09.80	SS, F	-	-	12
622	05.21.80	SS, F	-	-	6
675	01.11.83	SS, F	-	-	19
679	04.20.83	SS, F	-	-	12
3090	05.15.84	SS, T	-	-	1
728	10.31.84	SS, F	-	-	4
752	11.01.85	H	-	-	14
804	11.30.87	H, R, T	10	-	-
829	06.16.89	SS, F	18	-	10
833	06.20.89	H, R, T	8	-	-
835	08.28.89	SS, F	12	-	7
849	11.19.89	H, R, F	3	-	-
902	04.15.91	S, F	11	-	3
904	04.29.91	F	9	-	28
956	08.25.92	H	-	-	36
978	02.02.93	SS, F	9	-	-
1012	02.28.94	W	-	-	8
1049	05.08.95	R, F	5	-	7
1169	01.12.97	W	-	-	3
1246	09.09.98	H	3	-	16
1264	12.23.98	W	-	18	-
1269	04.03.99	T	1	-	4
1314	01.27.00	W	-	6	-
1357	12.11.00	W	-	8	-
1380	06.05.01	F	-	3	21
1435	09.21.02	TS	3	-	13
1437	10.03.02	H	1	7	36
1521	05.12.04	F	9	-	-
1548	09.13.04	H	-	8	18

Explanation for Declaration Type

D	Drought
F	Flood
H	Hurricane
R	Rain/Storm
SS	Severe Storm
T	Tornado
TS	Tropical Storm
W	Winter Storm

In 2003, with the support of FEMA, the OHSEP developed the *State of Louisiana Hazard Profiles* (Profiles). Much of the remainder of this section is excerpted from that document. Additional material from the Profiles is contained in Appendix D and specific references are included in Appendix B. The Profiles were an important first step toward developing a comprehensive plan for damage prevention. As required by Federal regulations under the DMA 2000, the Profiles contain an overview of the natural hazards that can affect Louisiana.

The Profiles went beyond the DMA 2000 requirements to profile a number of manmade hazards as well. In this report, natural hazards include those caused by naturally occurring climatological, geological, hydrologic, or seismic events, while manmade hazards include those created or heavily influenced by human actions.

The Profiles present information on the likelihood of occurrence, possible magnitude or intensity, areas of the State that can be affected (maps are included where appropriate), and conditions that influence the manifestation of the hazard. This information provided the basis for assessing the State's vulnerability to hazards, in terms of casualties and property damage, and provided direction for setting mitigation priorities in the Plan. The hazards contained in the Profiles were selected in part from a comprehensive list of hazards found in the 1997 "*Multi-Hazard Identification and Risk Assessment: A Cornerstone of the National Mitigation Strategy*" by FEMA. The Profiles helped to eliminate from further consideration hazards that are not significant threats to Louisiana.

Table 4-2 lists the broad range of hazards identified and evaluated for this Plan and describes the results of the preliminary investigation. As part of this study, four hazards that were included in the Profiles have been deleted from consideration: Landslide, Snow Avalanche, Tsunami and Volcano. At best, one or two of these could be described as theoretically possible (e.g., Tsunami) but the SHMPC considers these four as highly unlikely and therefore decided not to include them in this Plan.

Table 4-2: Disposition of Hazards Evaluated in Preliminary Investigation

Identified Hazard (occurred historically in the State)	Comments	Hazards Profiled in Plan (1)
Natural Climatic and Geologic Hazards		
Coastal Erosion	The effects of Coastal Erosion are considered under Storm Surge and Subsidence (Land Loss)	-
Dust Storm	Not considered a significant threat by the SHMPC and therefore is not profiled	-
Drought	-	Drought (2)
Earthquake	-	Earthquake (2)
Expansive Soil	Not considered a significant threat by the SHMPC and therefore is not profiled	
Flood	-	Flood
Fog	Not considered a significant threat by the SHMPC and therefore is not profiled	-
Hailstorm	-	Hailstorm (2)
High Wind	-	High Wind
Hurricane / Tropical Cyclone	The effects of Hurricanes and Tropical Cyclones are considered under Flooding, High Wind, and Storm Surge.	-
Ice Storm	-	Ice Storm
Lightning	-	Lightning (2)
Sea Level Rise	The impact of Sea Level Rise is considered as part of Subsidence (Land Loss).	-
Severe Summer Weather / Extreme Heat	Not considered a significant threat by the SHMPC in comparison to other significant climatic events and therefore not profiled	-

Identified Hazard (occurred historically in the State)	Comments	Hazards Profiled in Plan (1)
Severe Winter Storm / Extreme Cold	Not considered a significant threat by the SHMPC in comparison to other significant climatic events and therefore not profiled	-
Storm Surge	-	Storm Surge
Subsidence (Land Loss)	-	Subsidence (Land Loss)
Tornado	The effects of Tornadoes are considered under High Wind.	-
Wildfire	-	Wildfire
Manmade Hazards (3)		
Dam and Levee Failure	-	Dam and Levee Failure
Hazardous Material Incident	-	Hazardous Material Incident
Natural Biohazard Incident	-	Natural Biohazard Incident(2)
Nuclear Facility Incident	Nuclear Facility Incident is considered under Hazardous Material Incident	-

Notes

(1) Hazards considered as significant enough threats that also lend themselves to attainable mitigation actions.

(2) Based on the results of the Profiles, this hazard is either not considered significant by the SHMPC in comparison to the other profiled hazards or the extent to which the hazard can be mitigated is very small. Therefore, technical risk assessments are not included for these hazards in Sections Five and Six. However, these hazards are referenced in the Mitigation Action Plan (see Section Eight) as part of action items focused on public and state agency awareness as well as options and best practices for mitigation (see Appendix H).

(3) Only accidental occurrences of manmade hazards are considered as part of the Plan.

As a result of OHSEP and SHMPC consideration of their relative impacts, of the 13 hazards profiled in this document, the threat posed by the following eight hazards was considered significant enough to warrant formal risk assessments in this Plan .

Natural hazards:

- Flood
- High wind
- Ice storm
- Storm surge
- Subsidence (Land Loss)
- Wildfire

Manmade hazards:

- Dam and levee failure
- Hazardous material incident

The OHSEP and SHMPC consider these hazards to be the most prevalent in Louisiana, based on recent disaster history in the State and the exposure of its residents, property owners, and State-owned and operated facilities.

Coordination with Other State Emergency Management Planning Efforts

As noted in Section Three, coordination with the OHSEP Planning Division regarding on-going revisions to the State of Louisiana EOP was included as part of the planning process. This coordination included making sure that recommendations in the two plans are internally consistent in areas where potential overlaps exist. In addition, it is important to account for hazards listed as areas of concern in the EOP that are different or more extensive from the ones listed here. The hazards included in the EOP include the following:

Natural Hazards:

- Drought
- Earthquake
- Flood
- Hurricane / Tropical Storm
- Severe Storms
- Subsidence
- Tornado
- Wildfire
- Freezes
- Erosion
- Water shortages

Technological Hazards:

- Airplane Crash
- Civil Disorder
- Dam Failure
- Enemy/Terrorist Attack
- Energy Shortage
- Hazardous Materials Fixed Facility Incident
- Hazardous Materials Transportation Incident
- Oil Spill
- Utilities Failure
- Industrial Accidents
- Nuclear Attack
- Chemical/Biological Warfare

All 13 of the hazards profiled in this Plan are also included in the EOP.[14] The EOP considers a number of additional hazards. The longer list of hazards addressed in the EOP is due to differences in the basic foci of the two plans. The EOP is intended to prepare the State to respond under emergency conditions to all manner of hazards while the emphasis in this Plan is on identifying pre-disaster mitigation activities and projects. For example, hazards from the EOP list that present a clear need for developing coherent response and recovery strategies but do not lend themselves readily to pre-disaster mitigation include:

- Airplane Crash;
- Civil Disorder; and
- Intentional acts and warfare.

[14] [Note to Draft Plan Reviewers: OHSEP staff is working on resolving any significant differences in terminology between the two plans.]

4.4 Hazard Profiles

The following pages include a brief description of important issues related to the hazards addressed in this Plan. These profiles also include the summary mapping for the 13 profiled hazards.

Appendix D contains the full description of each hazard including the nature of the hazard, disaster history, probability of occurrence and magnitude.

Drought

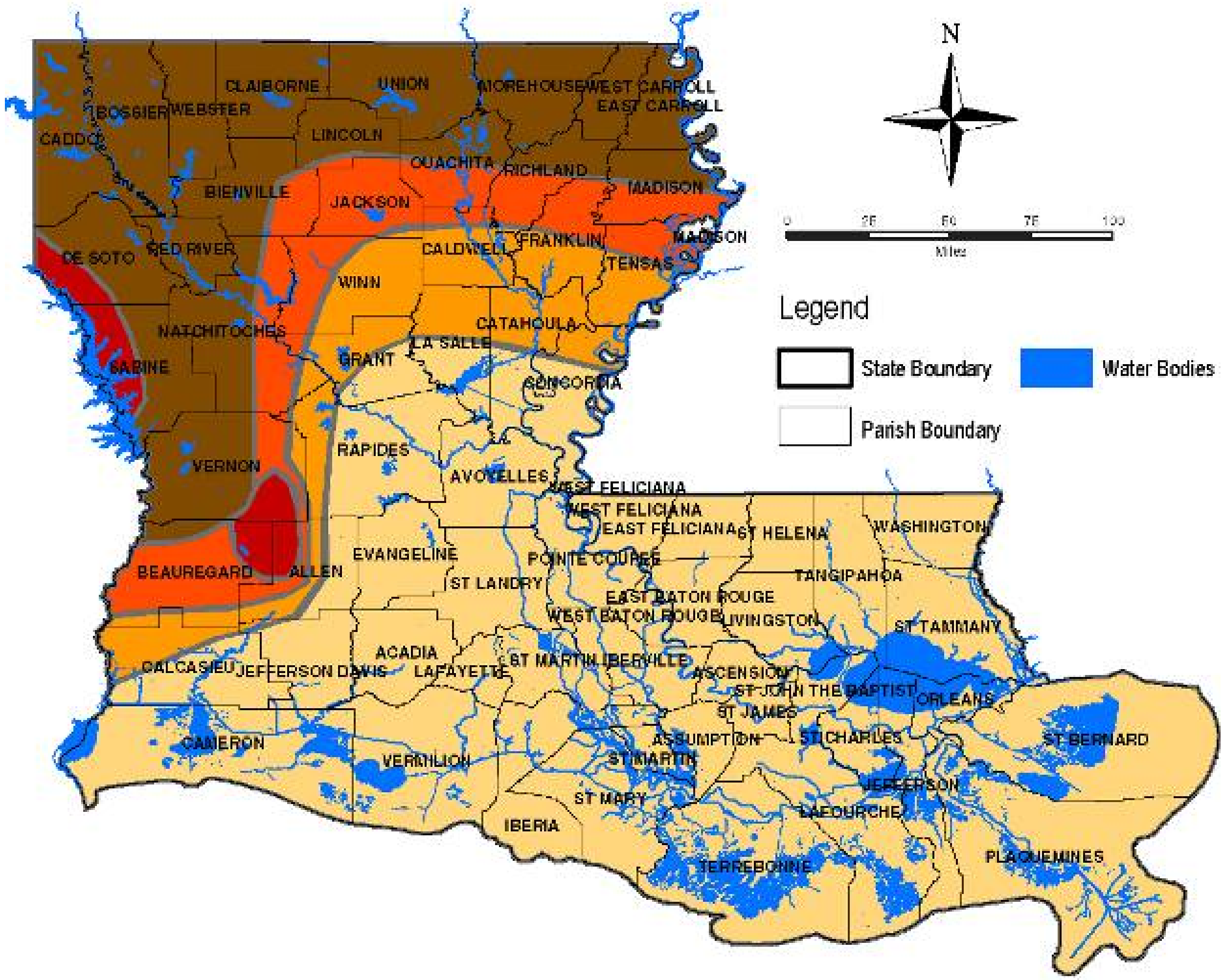
Drought is a normal part of virtually all climatic regimes, including areas with high and low average rainfall. Drought is the consequence of a natural reduction in the amount of precipitation expected over an extended period of time, usually a season or more in length.

Louisiana, although featuring several large water bodies, thousands of miles of rivers, streams, and bayous, and thousands of acres of wetlands, has experienced occasional drought conditions. Northern parishes, especially, have experienced agricultural droughts, leading to severe soil-moisture decreases that have had serious consequences for crop production.

Map 4-2 shows the natural variations of the July to January mean river and stream flow information maintained by the U.S. Geological Survey (USGS) (FEMA, 1997). The southern half of the State of Louisiana, shown in light yellow, has stream flows greater than 2 cubic feet per second per square mile. Indicative of the region's high precipitation, low evapotranspiration, and low runoff potential due to a very flat, low-lying topography, however, rivers and streams in the northern and western parts of the State have lower mean flows. The July to January mean monthly flow with non-exceedance probability of 0.05 was selected as the threshold to characterize hydrologic drought. The July to January mean monthly stream flow will be less than this value, on average, once in 20 years. There is no commonly accepted return period or non-exceedance probability for defining the risk from hydrologic droughts that is analogous to the 100-year or 1% annual chance flood.

While Louisiana has suffered agricultural droughts in its northern parishes, droughts of such magnitude that they require urban and suburban water restrictions are rare. However, based on the results of the hazard profiling for this study, drought is not considered significant by the SHMPC in comparison to the other profiled hazards and the extent to which drought can be mitigated is very small. Therefore, technical risk assessments are not included for drought in Sections Five and Six.

Map 4-2: Hazard Profile - Drought



Mean flow in cubic feet per second per square mile

<0.1	0.1 - 0.5	0.5 - 1.0	1.0 - 2.0	>2.0

Source: Mult-Hazard Identification and Risk Assessment: A Cornerstone of the National Mitigation Strategy. FEMA, 1997

Earthquake

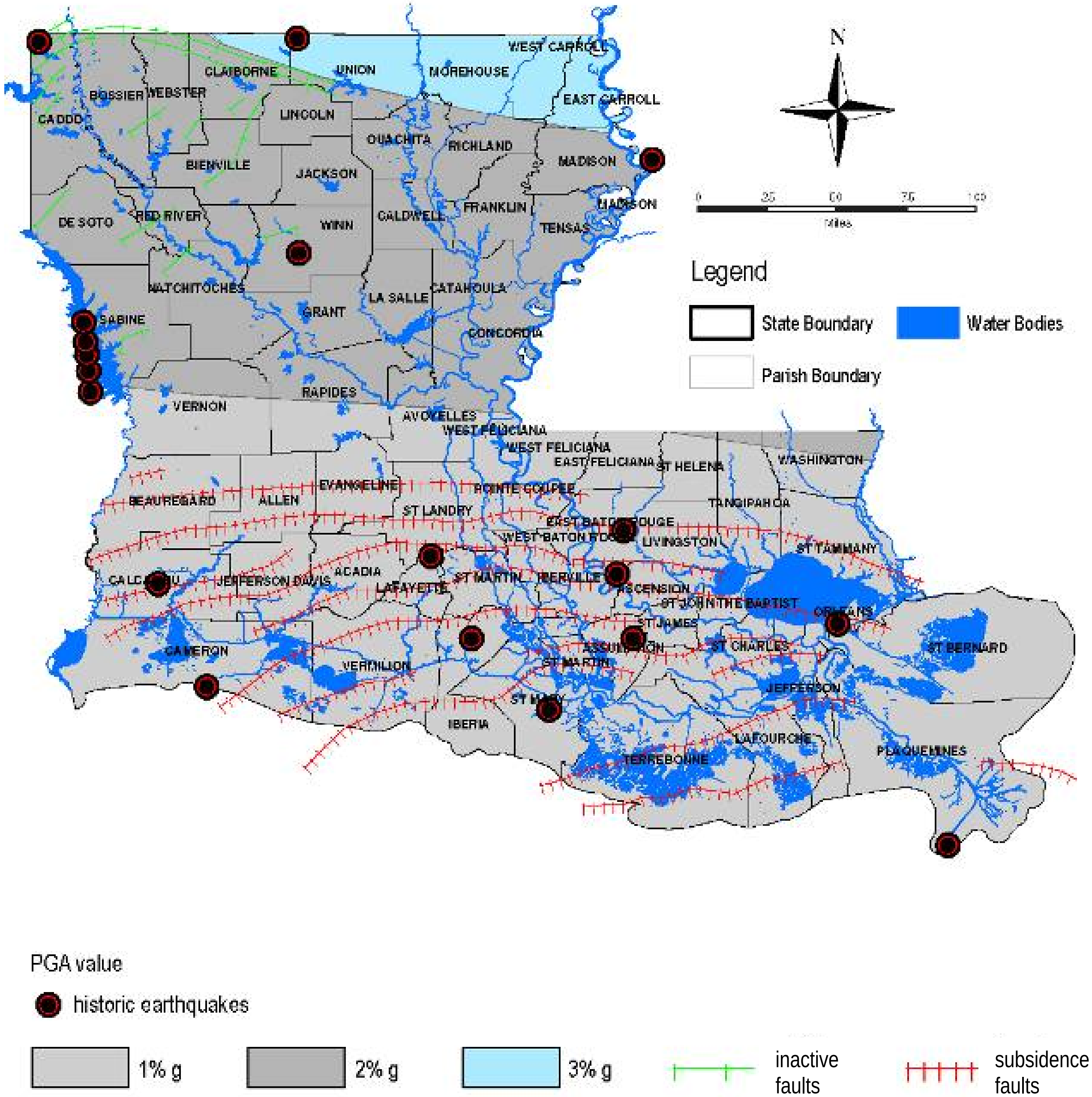
An earthquake is a sudden motion or trembling of the earth caused by an abrupt release of stored energy in the rocks beneath the earth's surface. The energy released results in vibrations known as seismic waves that are responsible for the trembling and shaking of the ground during an earthquake. Ground motion is expressed as peak ground acceleration (PGA).

Although Louisiana is an area of low seismic risk, a number of earthquakes have occurred in the State over the last 200 years. These earthquakes have had two distinct sources: a system of subsidence faults (also known as "growth faults") in southern Louisiana, and the New Madrid seismic zone to the north of Louisiana. Most of these earthquakes were of low magnitude and occurred infrequently.

Map 4-3 shows the PGA and the 10% probability of exceeding normal ground motion in 50 years for the State. This translates to a 1 in 475 chance of normal ground motion being exceeded by the amount shown on the map annually. The southern half of the State has a PGA of 1 percent gravity (1%g) and the northeastern part of the State has a PGA of 3%g; this can be compared to the New Madrid Seismic Zone, which has a PGA as high as 40%. It is important to note that Map 4-3 expresses a 10% probability; there is a 90% percent chance that normal ground motions will not be exceeded.

Based on the results of the hazard profiling for this study, earthquake is not considered significant by the SHMPC in comparison to the other profiled hazards. Therefore, technical risk assessments are not included for earthquake in Sections Five and Six.

Map 4-3: Hazard Profile - Earthquake



Source: Peak ground acceleration (%g) with 10% probability of exceedance in 50 years, USGS map, October, 2002.

Flood

Floods are naturally occurring events of rivers and streams. Excess water from snowmelt, rainfall, or storm surge accumulates and overflows onto banks and adjacent floodplains.

While FEMA's NFIP mapping program maps many floodplain boundaries, floods often go beyond the mapped floodplains or change course due to natural processes (e.g., accretion, erosion, sedimentation, etc.) or human development (e.g., filling in floodplain or floodway areas, or increased imperviousness within the watershed from new development). Over nine million households in the U.S. are located in floodplains. Most injuries and deaths related to flooding events occur when people are swept away by flood currents, and most property damage results from inundation by sediment and debris-filled water. Hundreds of floods occur each year, making flooding one of the most common hazards.

Flooding is a significant potential threat throughout Louisiana, representing the State's most prevalent and pervasive natural hazard threat. Louisiana is located along the southernmost part of the Mississippi River Basin, which has the largest drainage of any basin in North America. The State's sub-tropical climate has the potential for producing heavy rainfalls at any time of the year. Over the past century, there has been an apparent increase in large rainstorms and resultant flooding, particularly in the late winter and spring (OHSEP, 2001). Rainfalls of up to 10 inches in a two-day period are not uncommon and are capable of producing considerable flooding (refer to Section 4.2 – Climate for additional information). Mean annual precipitation decreases to the west and north, with the northwest corner of the State receiving an average of 48 inches annually, in contrast to the delta area in southeastern Louisiana, which receives an average of about 64 inches annually.

Flooding along the Mississippi and Atchafalaya Rivers more often results from upstream runoff than local rainfall (OHSEP, 2001). Major flooding on these waterways can seriously affect river and barge traffic, especially along the Mississippi River where cargo handling at the Port of New Orleans is a major industry for Louisiana. Frequent flooding is of particular concern in areas of active growth and development. However, the primary focus in Louisiana in terms of flooding impacts is on repetitive loss properties. Repetitive loss properties are defined as any property that is currently insured under the NFIP that has had two or more claims greater than $1,000 paid by the NFIP within any 10-year period since 1978. A few facts about repetitive loss properties in Louisiana provide an important perspective[15]:

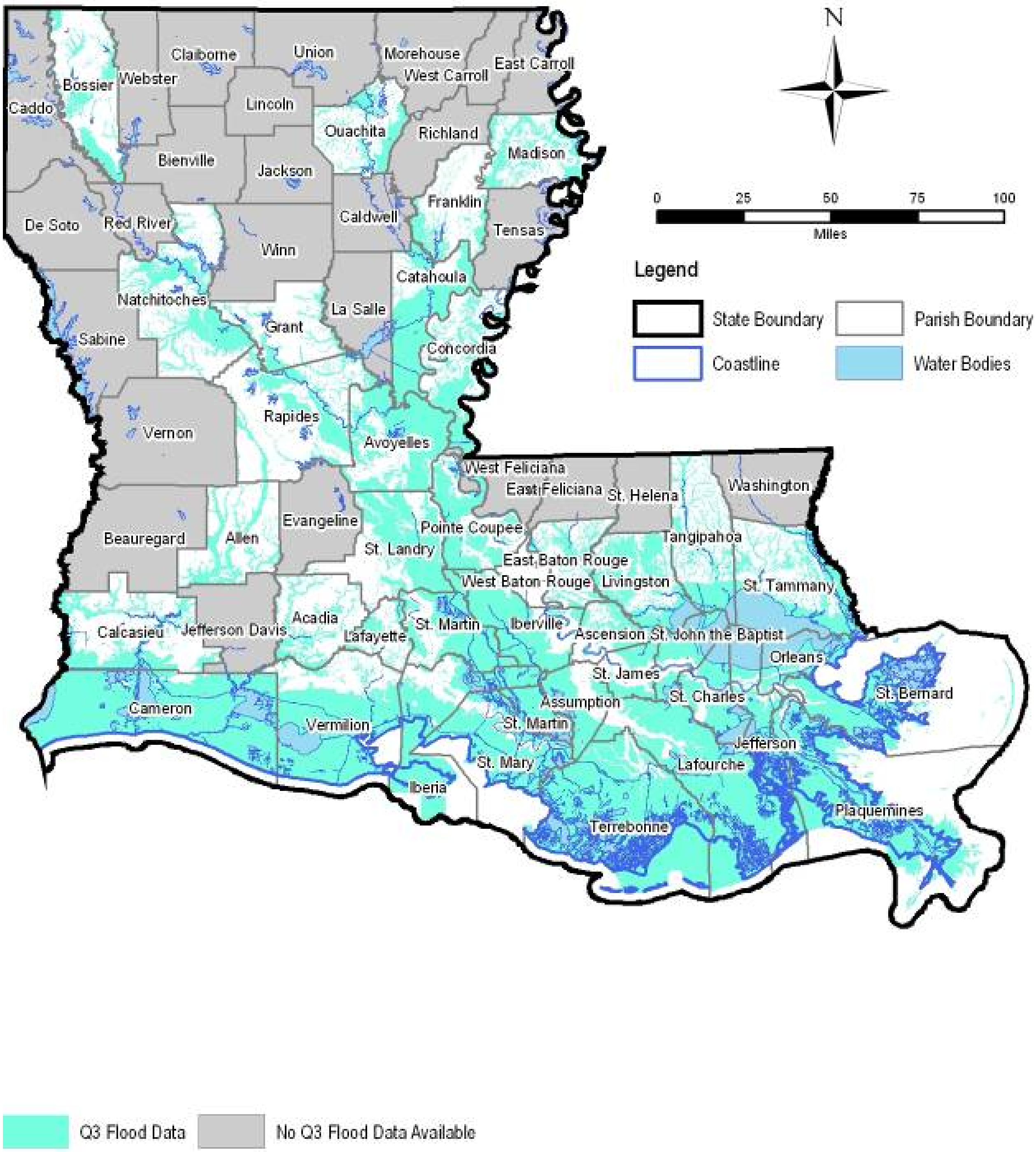
- Repetitive loss properties receive over 30% of claims dollars paid (approximately $200 million annually) but represent only 1 percent of all NFIP insured properties.
- Nationwide, FEMA has identified about 12,000 high priority repetitive loss properties that have experienced frequent significant flooding impacts.
- Of these high priority properties, 3,000, or 25%, are located in Louisiana, more than twice the number in any other state. Texas, New Jersey and Florida follow with 1,500, 1,000 and 1,000 respectively.

Map 4-4 shows the extent of 100-year floodplains in Louisiana (27 of the 64 parishes have no Q3 digital floodplain data, and therefore, have no 100-year flood zones depicted; two parishes - East Feliciana and Jackson - do not participate in the NFIP). Over 27% of land in Louisiana, particularly the southern parishes, lies within 100-year floodplains — floodplains with a 1% chance on average of being inundated in any given year.

Due to the extensive history of flooding and the high incidence of repetitive loss properties in the State, flood is one of the hazards included in the risk assessments and addressed in the Mitigation Action Plan.

[15] Statistics from web sites of the Association of State Floodplain Managers (ASFPM) and FEMA via P. Skinner at LSU AgCenter.

Map 4-4: Hazard Profile - Flood



Source: FEMA Q3 Flood Data

Hailstorm

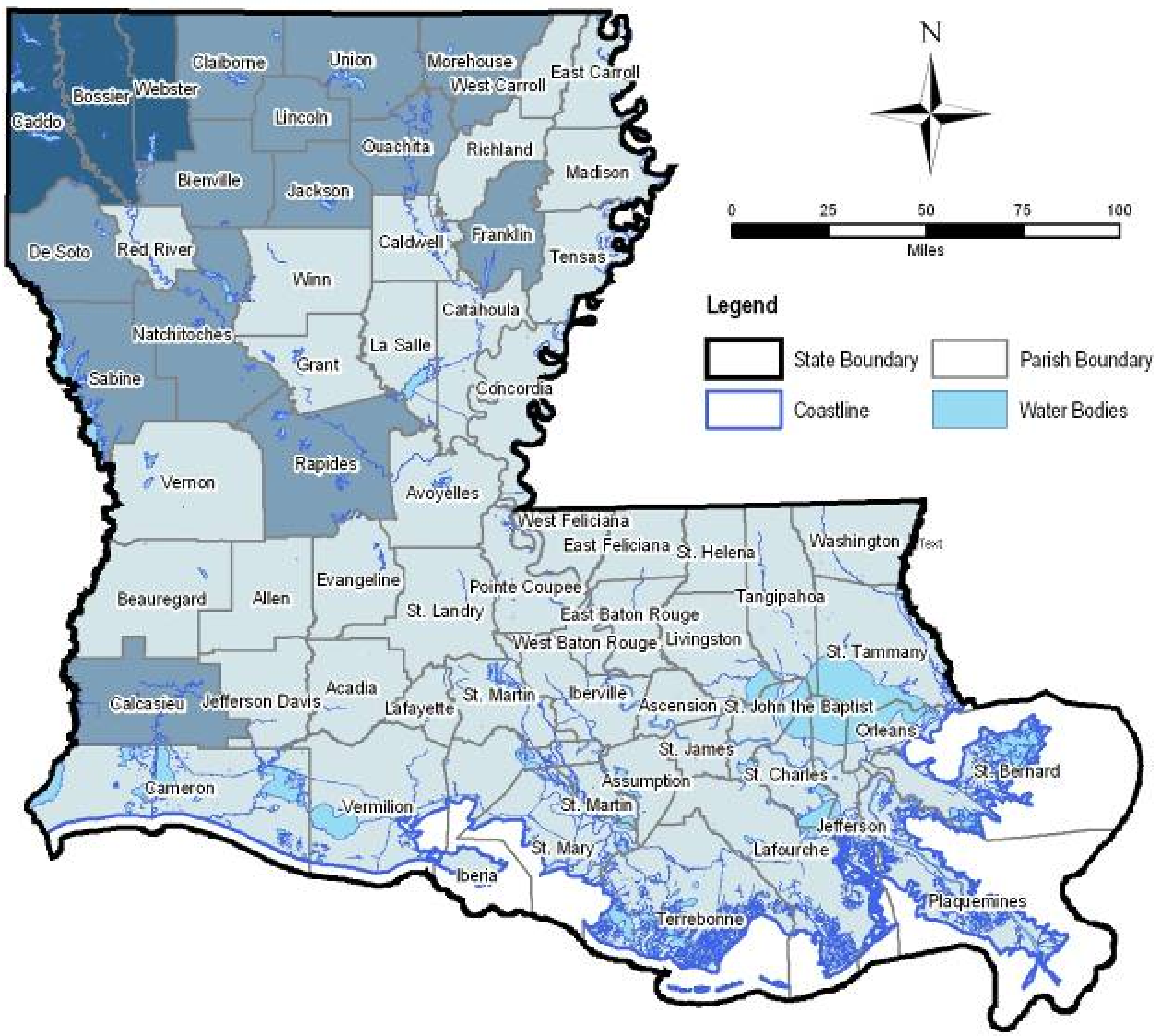
Hailstorms are severe thunderstorms in which chunks of ice fall along with rain. Hail develops in the upper atmosphere as ice crystals that are bounced about by high velocity updraft winds; the ice crystals accumulate frozen droplets and fall after developing enough weight. The size of hailstones varies and is a direct consequence of the severity and size of the thunderstorm— the higher the temperatures at the Earth's surface, the greater the strength of the updrafts and the amount of time hailstones are suspended, the greater the size of the hailstone.

Hailstorms generally occur more frequently during the late spring and early summer, a period of extreme variation between ground surface temperatures and jet stream temperatures that produce the strong updraft winds needed for hail development. Hailstorms can cause widespread damage to homes and other structures, automobiles, and crops. While the damage to individual structures or vehicles is often minor, the cumulative costs to communities, especially across large metropolitan areas, can be quite significant. The severity of hailstorms depends on the size of the hailstones, the length of time the storm lasts, and whether it occurs in developed areas.

Between 1955 and 2002, Louisiana experienced 792 days with hailstorms, an average of 17 storms annually. The average size of hailstones in Louisiana is 1.27 inches, and the median size is 1.00 inch.

Based on the results of the hazard profiling for this study, hailstorm is not considered significant by the SHMPC in comparison to the other profiled hazards and the extent to which hailstorm can be mitigated is very small. Therefore, technical risk assessments are not included for hailstorm in Sections Five and Six.

Map 4-5: Hazard Profile - Hail Storms



Previous Hail Storms

Less than 50 Storms | 50 - 100 Storms | Over 100 Storms

Source: NOAA

not **reviewed**

High Wind (Hurricane)

Tropical storms and hurricanes are large-scale systems of severe thunderstorms that develop over tropical or subtropical waters and have a defined, organized circulation. Tropical storms have wind speeds of 39 mph to 74 mph; hurricanes have a maximum sustained (meaning 1-minute average) surface wind speed of at least 74 mph. Hurricanes and tropical cyclones get their energy from warm waters and lose strength as they move over land.

Hurricanes and tropical storms have proven to be Louisiana's costliest and deadliest natural phenomenon. At least three storms have produced 200 or more deaths, including the storm of 1893, in which roughly 2,000 lives were lost. Hurricanes Betsy in 1969 and Andrew in 1992 both created losses of about $1 billion over the multi-state area that included Louisiana. More recently, Louisiana received presidential disaster declarations for Tropical Storm Allison in June 2001, Hurricane Isadore in September 2001, Hurricane Lili in October 2002 and Hurricane Ivan in 2004.

The central Gulf of Mexico coastline is among the most hurricane-prone locations in the U.S. While the Atlantic Basin hurricane season officially extends from June 1 to November 30, Louisiana has experienced storms as early as late May and has not experienced a storm during the month of November for more than 100 years. The peak hurricane activity in the State occurs in September. Hurricanes and tropical storms can bring severe winds, storm surge flooding along coastal regions, high waves, coastal erosion, extreme amounts of rainfall, thunderstorms, lightning, inland flooding, and tornadoes. One of the most serious hurricane-related hazards for Louisiana is high wind. Coastal and inland areas are also vulnerable to hurricane-spawned tornadoes (refer to D.5). Some hurricanes and tropical storms have enough moisture to cause extensive flooding throughout the State, often to the 100- or 500-year flood elevation. Map 4-6 shows that all of Louisiana, including its northern reaches, can experience strong tropical storm- to hurricane-force winds.

High Wind (Tornado)

Tornadoes are rapidly rotating funnels of wind extending from storm clouds to the ground. They are created during severe weather events, such as thunderstorms and hurricanes, when cold air overrides a layer of warm air, causing the warm air to rise rapidly.

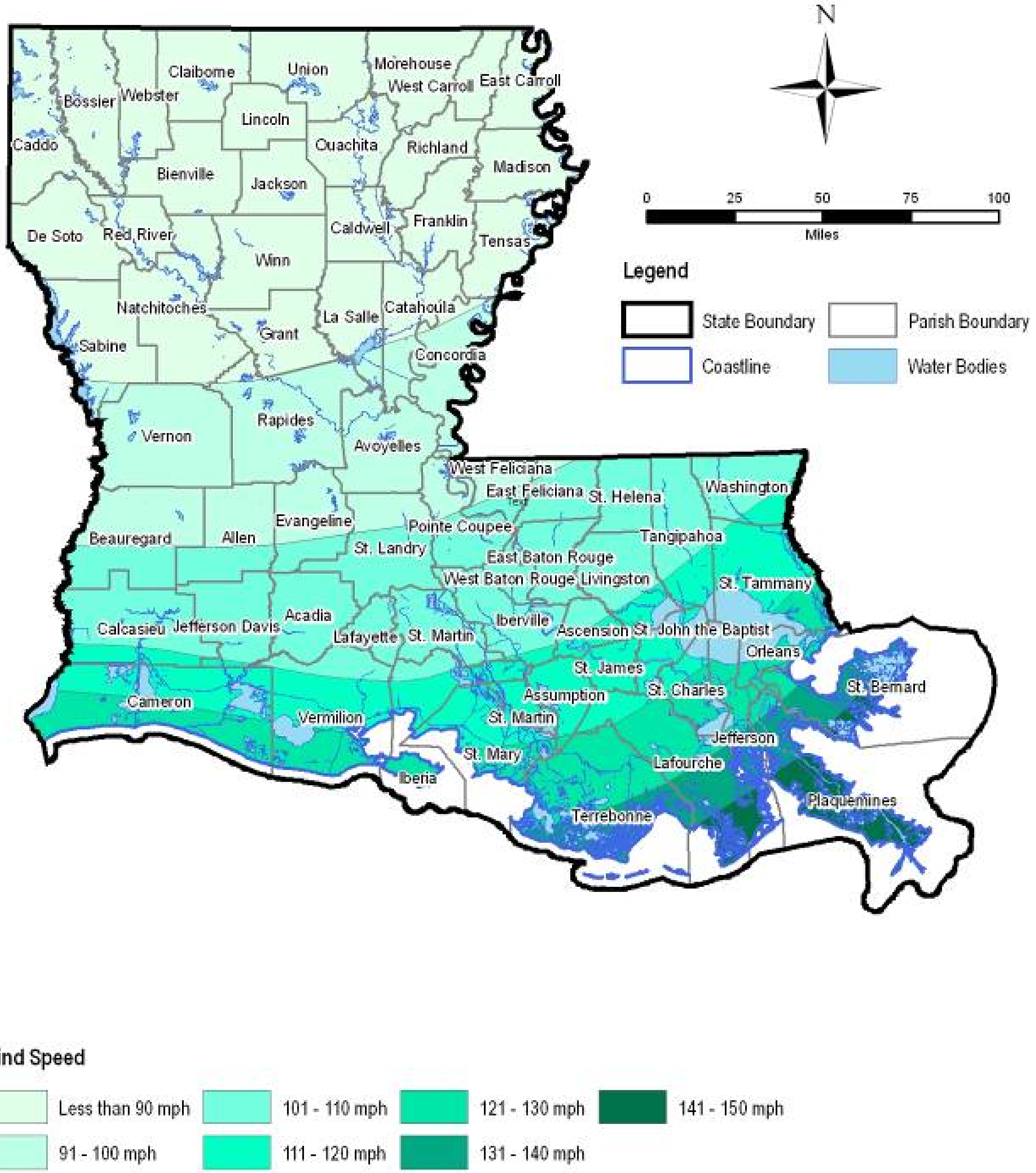
While the vast majority of tornado events in Louisiana have produced little damage and few injuries, the State has experienced several violent and fatal tornado outbreaks, most recently in November 0f 2004 (see Figure 4-1). The State has had six federal disaster declarations for tornado events since 1965. According to the National Oceanic and Atmospheric Administration (NOAA), one of the deadliest tornado outbreaks in U.S. history occurred in Louisiana and neighboring states during April 24-26, 1908. A number of violent tornadoes moved through parts of Louisiana, Mississippi, and Alabama, killing 324 people and injuring 1,652 others. The worst damage took place in Amite, Louisiana, where 29 people died.

The midsection of the U. S., including Louisiana, experiences a higher rate of tornadoes than other parts of the country because of the recurrent collision of moist, warm air moving north from the Gulf of Mexico with colder fronts moving east from the Rocky Mountains. Among the most unpredictable of weather phenomena, tornadoes can occur at any time of day, in any State, in any season. In Louisiana, tornadoes have a higher frequency in the spring months of March, April, and May.

Figure 4-1: Damage from Olla Louisiana due to November 23, 2004 Tornadoes[16]

[16] [Note to Draft Plan Reviewers: If there are any other digital photographs of damage or mitigation efforts related to any of the hazards included in the Plan, these can be included in subsequent versions of the Plan if provided to OHSEP.]

Map 4-6: Hazard Profile - High Winds



Source: ASCE Standard 7-02

Ice Storm

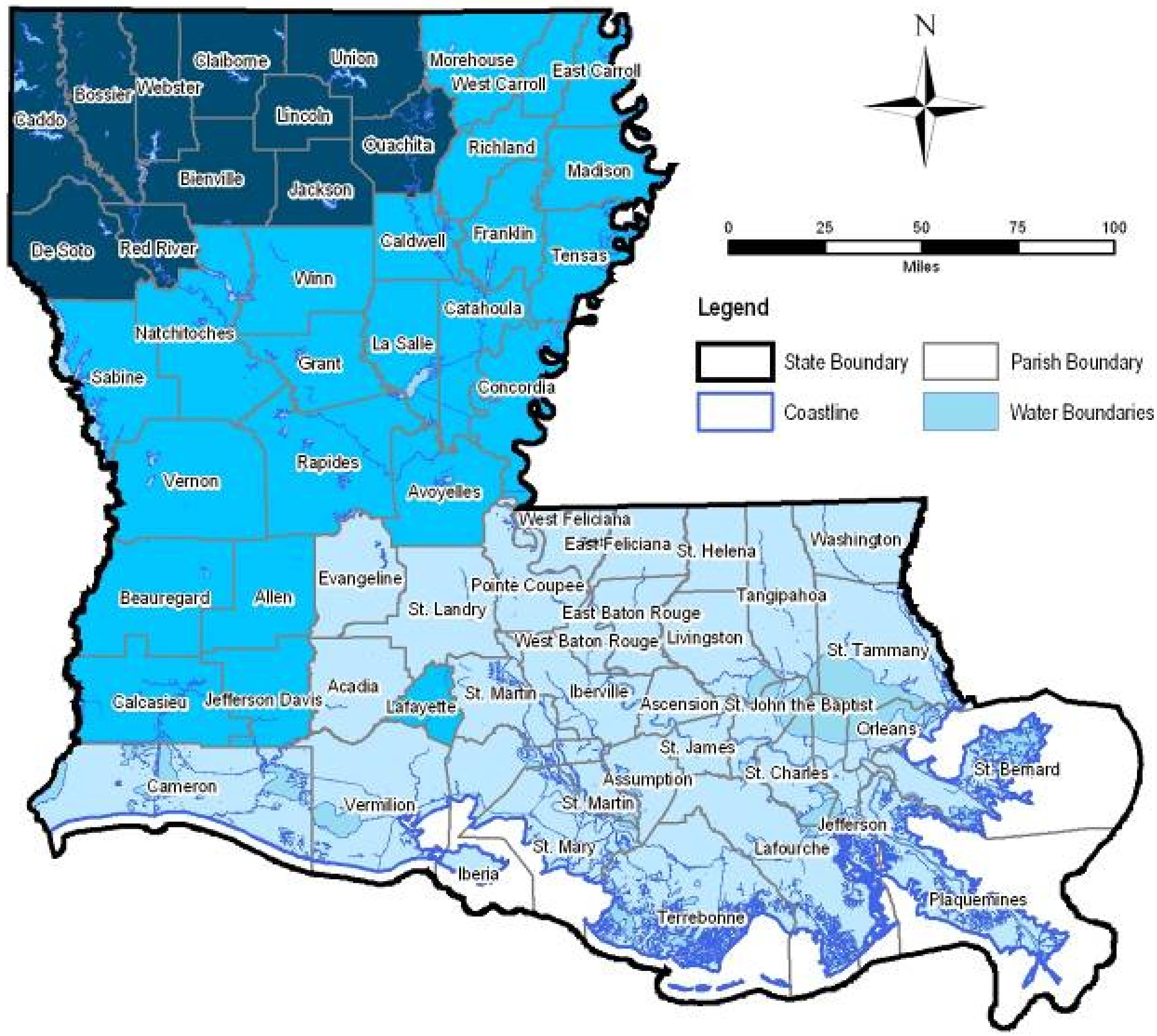
Severe winter weather in Louisiana consists of freezing temperatures and heavy precipitation, usually in the form of rain, freezing rain, or sleet, but sometimes in the form of snow. Severe winter weather affects all but the extreme coastal margins of the State. Winter months in Louisiana (December, January, and February) have average seasonal temperatures ranging from the mid-40s over northern Louisiana to the low 50s across the southern parishes. While average seasonal temperatures remain above freezing statewide, cold fronts extending from Canada through the State occur at least once during most winters.

Louisiana recently has had several bouts of severe winter weather. In February 1994, a severe ice storm spread freezing rain across the northern third of the State. Ice accumulations of 2 to 3 inches combined with gusty winds snapped power lines, power poles, and trees. More than 100,000 people were without electric power for several days, and over 256,000 acres of forest were damaged. The State suffered an estimated $13.5 million in damages. Several ice storms within a two-week period in December 2000 resulted in similar damage, causing over 250,000 people to be without power, primarily in northern Louisiana. About 30 transmission lines atop “H”-shaped steel towers snapped due to the weight of the ice and numerous traffic accidents occurred across the State. With millions of dollars in damages and one death attributed to the storms, Louisiana received a presidential disaster declaration.

While Louisiana is far less likely to have heavy snow and ice accumulation than most other states, severe winter weather is expected to occur at least once each winter. Data from the National Climatic Data Center (NCDC) shows that the entire State of Louisiana is in the lowest category of probable snow depth — 0 to 25 centimeters of snow depth with a 5% chance of being equaled or exceeded in any given year. Louisiana ice storms that have had severe consequences for the State have generally delivered 1 to 3 inches of ice accumulation. Map 4-7 indicates the number of ice storms per parish over the ten-year period between 1994 and 2003.

Due to recent history of damaging ice storms in the State, ice storm is one of the hazards included in the risk assessments and addressed in the Mitigation Action Plan.

Map 4-7: Hazard Profile - Ice Storms



Previous Ice Storms

No Storms
1 - 4 Storms
5 - 10 Storms

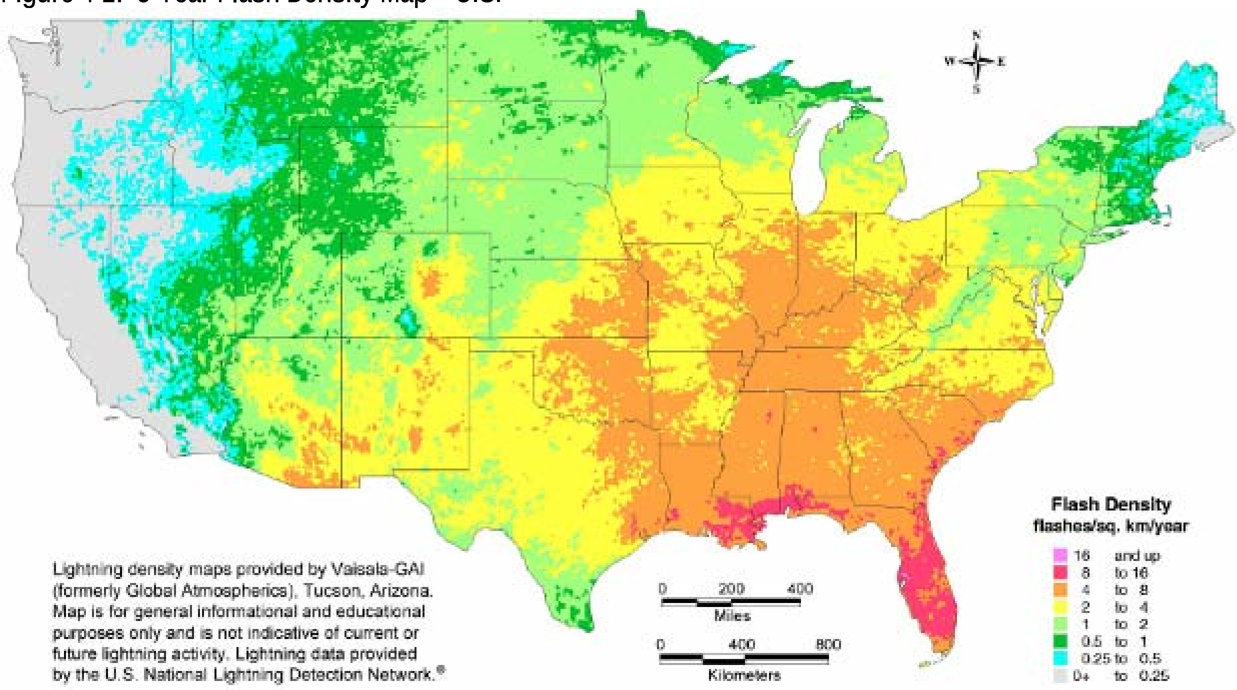
Source: NOAA

Lightning

Lightning typically occurs as a by-product of a thunderstorm. The action of rising and descending air in a thunderstorm separates positive and negative charges, with lightning the result of the buildup and discharge of energy between positive and negative charge areas. Water and ice particles may also affect the distribution of the electrical charge. In only a few millionths of a second, the air near a lightning strike is heated to 50,000°F, a temperature hotter than the surface of the sun. Thunder is the result of the very rapid heating and cooling of air near the lightning that causes a shock wave.

On a national scale, the State of Louisiana is second only to Florida in terms of “flash density”, i.e., the number of lightning flashes per square kilometer per year (see Figure 4-2). Map 4-8 also shows the average number of lightning flashes that have been experienced per square mile in Louisiana parishes (based on the period from 1999 to 2003).

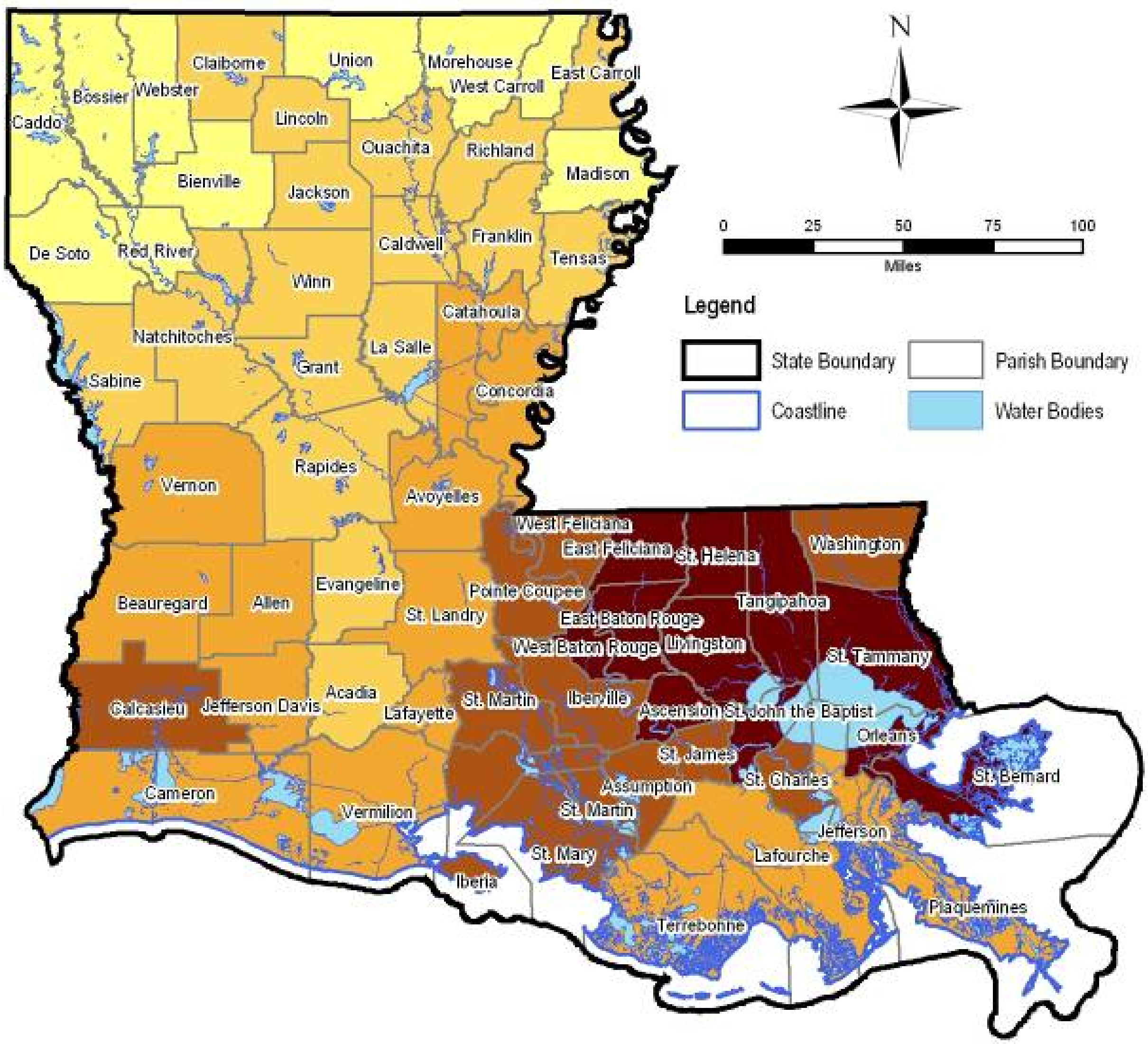
Figure 4-2: 5-Year Flash Density Map – U.S.



Source: Vaisala’s U.S. National Lightning Detection Network®

However, since the extent to which lightning strikes can be predicted at any particular location and the extent to which this hazard can be mitigated is very small, technical risk assessments are not included for lighting in Sections Five and Six.

Map 4-8: Hazard Profile - Lightning



Average Yearly Lightning Flashes per Square Mile (1999-2003)

11.09 - 12.75 | 12.76 - 15.50 | 15.51 - 18.25 | 18.26 - 21.50 | 21.51 - 27.00

Source: Vaisala's U.S. National Lightning Detection Network©.

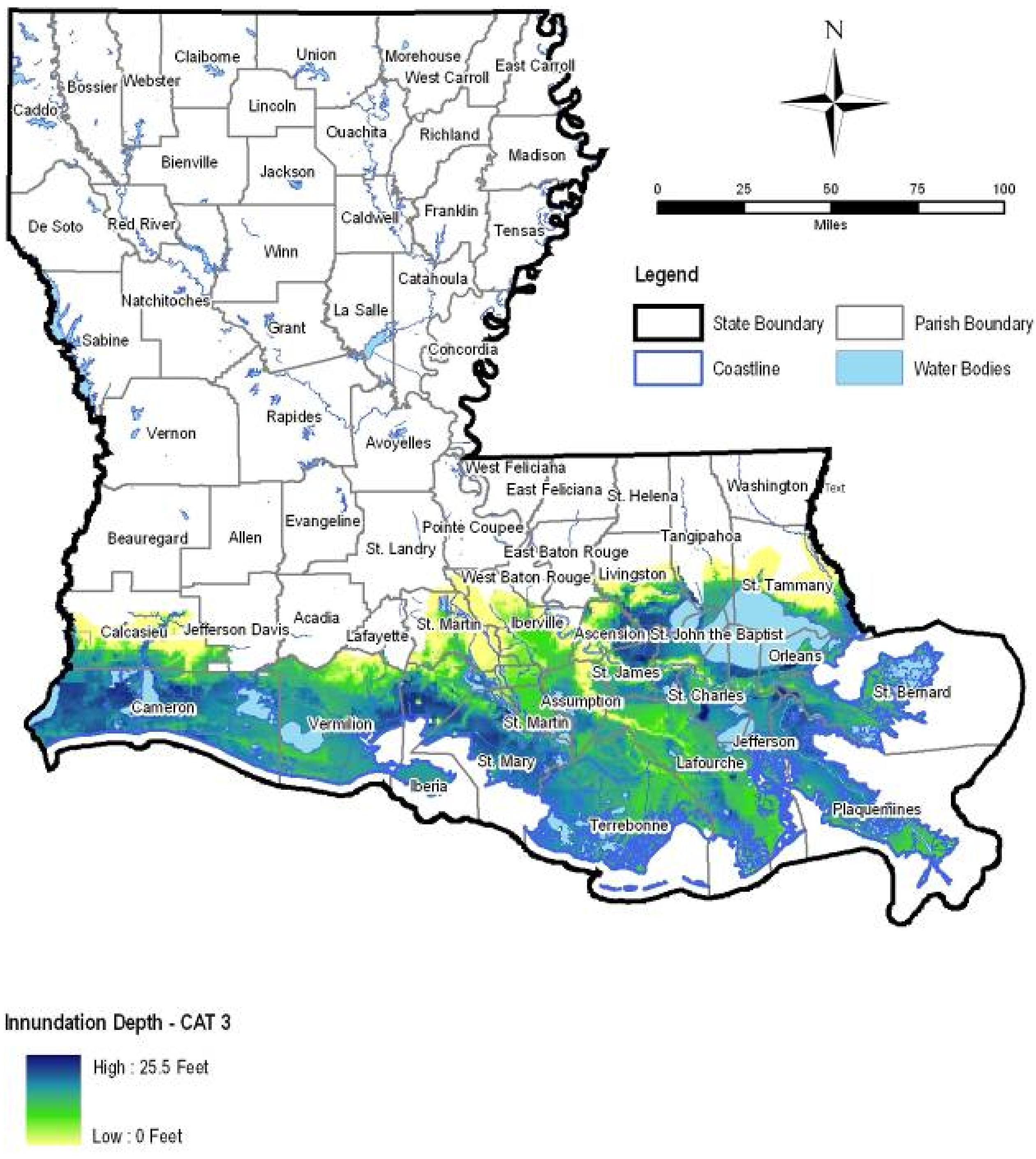
Storm Surge

Storm surges are large waves of ocean water that sweep across coastlines where a storm makes landfall. The more intense the storm, the greater the height of the storm surge and the higher the storm surge, the greater the damage to the coastline. Storm surges inundate coastal floodplains, wash out dunes, cause backwater flooding through coastal river mouths, generate large waves that run up and flood coastal beaches, and can flood streets and buildings in coastal communities. Storm surge areas can be mapped by the probability of storm surge occurrences using Sea, Lake and Overland Surges from Hurricanes modeling (referred to as SLOSH modeling).

Map 4-9 depicts SLOSH models run to identify areas of southern Louisiana that can be affected by storm surge inundation from category 3 hurricanes (refer to D.5 for more information on hurricane categories). SLOSH models represent the storm surge of hundreds of simulated hurricanes, taking into account storm wind intensities, forward speeds, directions of motion, and radius of maximum winds. Shallow coastal bathymetry increases the magnitude of a storm surge. The coastal bathymetry of southeastern Louisiana, with its low, flat topography and land surface elevations that in many places dip below sea level, can experience storm surges up to 100 miles inland. Category 3 storms can bring depths up to 24 feet as far north as the City of New Orleans. Category 5 storms can produce depths as high as 36 feet. Furthermore, lakes along the coast, namely, Lake Maurepas, Lake Borgne, and Lake Pontchartrain, exacerbate the effects of coastal flooding because of wave effects that can regenerate over inland lakes. It is important to note that the map represents the cumulative storm surges for hundreds of modeled hypothetical hurricane tracks; no single hurricane event would produce the inundation pattern depicted on the map.

Due to the high potential for damage from storm surge in the State, this hazard included in the risk assessments and addressed in the Mitigation Action Plan.

Map 4-9: Hazard Profile - Storm Surge



Source: SLOSH data obtained from NOAA

Subsidence (Land Loss)

In Louisiana, the two most important causes of land "loss" are sea-level rise and land subsidence. Subsidence and sea-level rise impact Louisiana in a similar manner, making it difficult to separate the effects of one from the other.

Sea-level rise means exactly that – the level of the sea is rising relative to land at the coastline. The most prominent causes of sea-level rise are the melting of the Earth's glacial ice caps and sea floor spreading.

Subsidence refers to the combined effect of numerous natural processes, such as compaction of poorly consolidated sediments and geologic faulting. In areas of the coast where subsidence is high and riverine influence is minor or virtually non-existent, such as in areas of western Barataria Basin and eastern Terrebonne Basin, wetland habitats sink and convert to open water.

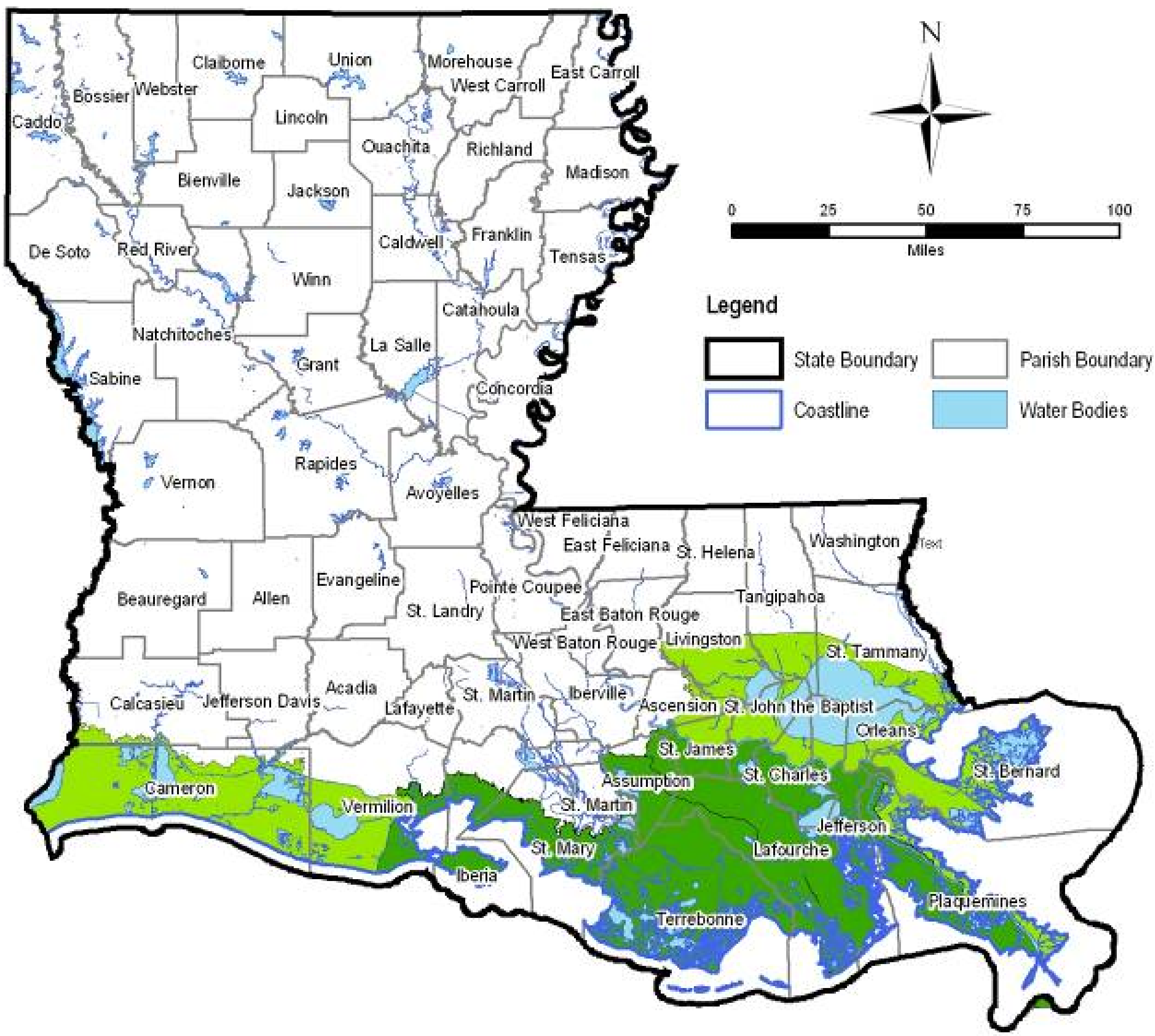
Causes of subsidence in coastal Louisiana areas include the isostatic adjustment of land due to Mississippi River sediment-loading and the localized compaction of older sediments. The term "isostatic adjustment" refers to the attempts of the Earth's crust to maintain equilibrium. In this case, large amounts of sediment are being deposited by the Mississippi River in a relatively short amount of time, causing the crust to compensate for the extra weight of the sediment.

Sea-level rise and land subsidence have not been identified as significant contributors to direct disaster damages in Louisiana. For the most part, sea-level rise and subsidence are two processes that are slow acting, so their effects are not as evident as sudden-occurrence hazards like earthquakes. While the effects in the New Orleans metropolitan area are significant, subsidence is a "creeping" hazard event, one with chronic, not acute impacts. The only hazard to be documented as a direct result of subsidence is the appearance of sinkholes over a mining operation in Weeks Island. The repeated removal of underground materials (originally salt and later oil) resulted in the formation of a sinkhole in 1992. The Weeks Island facility was decommissioned as a result of this discovery.

Subsidence is already occurring throughout much of coastal Louisiana. An acre of land along the coast disappears every 24 minutes. The highest rate of subsidence is occurring at the Mississippi River delta (3.5 feet/century). Subsidence rates decrease away from the delta in a northeast, northwest, and western direction. As for sea-level rise, the USGS and the Environmental Protection Agency (EPA) have each developed their own estimates. The USGS estimates that the rate of sea-level rise in Louisiana is approximately 3.0 feet/century and the EPA estimates that it is approximately 3.4 feet/century. The results of projecting this rate of sea-level rise for a 50-year period from 2000 to 2050 are depicted on Map 4-10.

Due to the long-term implications of subsidence for the State, this hazard included in the risk assessments and addressed in the Mitigation Action Plan.

Map 4-10: Hazard Profile - Subsidence (Land Loss)



Subsidence (Land Loss)

High Projected Losses

Medium Projected Losses

Source: USGS National Wetlands Research Center

Wildfire

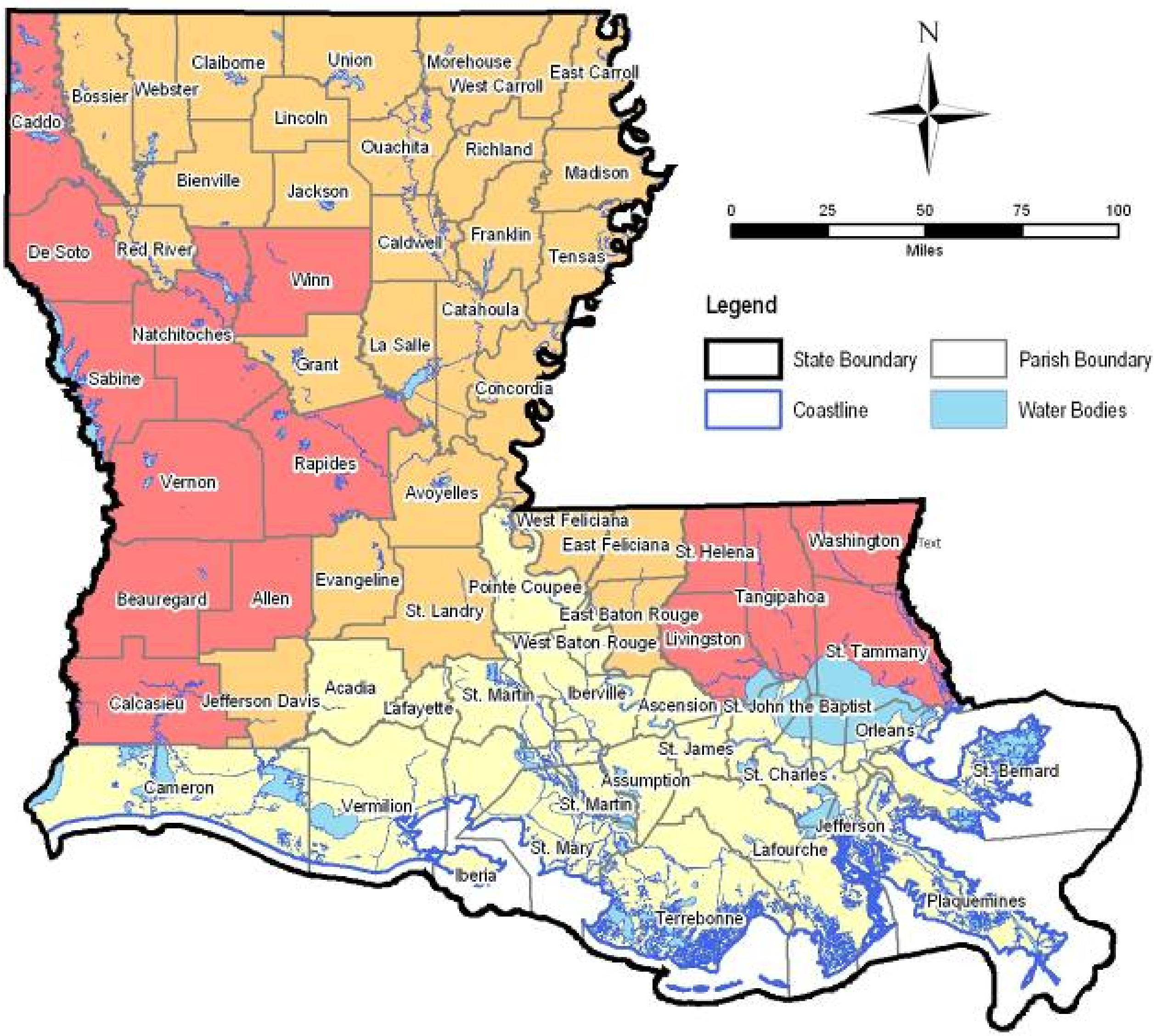
A wildfire is an uncontrolled fire spreading through vegetative fuels, exposing and possibly consuming structures. They often begin unnoticed, spread quickly, and are usually signaled by dense smoke that fills the area for miles around. Naturally occurring and non-native species of grasses, brush, and trees fuel wildfires. Wildfires can be caused by human acts, such as arson or careless accidents, or by the natural occurrence of lightning.

From 2000 to 2002, the average number of forest fires was 2,418 per year, and the average number of acres burned was 37,761. According to the State Forestry Division, Louisiana's forestlands cover 48% or 13.8 million acres of the State's area. The urban-wildland interface is the area in which development meets wildland vegetation. Both vegetation and the built environment provide fuel for fires. As development near wildland settings continues, more and more people are being exposed to wildfire danger.

Wildfire danger can vary greatly season to season and is exacerbated by dry weather conditions. In dry and drought conditions, wildfires can become quite intense, burning dead forest debris on forest floors, dried grasses, and brush. Because most fires in Louisiana forests are caused by arson and other careless acts committed by people, the location and severity of fires is largely unpredictable. However, the Louisiana Department of Agriculture and Forestry does provide general assessments of the risk of wildfire based on geographic location in the State (see Map 4-11).

Due to the relative risk for certain areas of the State and an emphasis on wildfire prevention at the Federal level, this hazard included in the risk assessments and addressed in the Mitigation Action Plan.

Map 4-11: Hazard Profile - Wildfire



Wildfire Risk

High Risk | Medium Risk | Low Risk

Source: Louisiana Department of Agriculture and Forestry

Dam and Levee Failure

Dams are water storage, control, or diversion barriers that impound water upstream in reservoirs. Dam failure is a collapse or breach in the structure. While most dams have storage volumes small enough that failures have little or no repercussions, dams with large storage volumes can cause significant flooding downstream. In Louisiana there are 365 dams included in the U.S. Army Corp of Engineers (USACE) National Inventory of Dams. Map 4-12 shows dam locations per the USACE's inventory.

Levees are flood control barriers constructed of earth, concrete, or other materials. Levee failure involves the overtopping, breach, or collapse of the levee. Levee failure is especially destructive to nearby development during flood and hurricane events. The northern half of Louisiana is protected by levees on the Ouachita River under the authority of the Vicksburg District of the USACE. Coastal and southern Louisiana is protected by an extensive levee system under the authority of the New Orleans District of the USACE; this system includes 30,000 square miles of Louisiana south of Alexandria, including 961 miles of river levees in the Mississippi River and Tributaries Project, 449 miles of river levees in the Atchafalaya Basin, and 340 miles of hurricane-protection levees. Map 4-13 shows the location of the major levees in these basins.

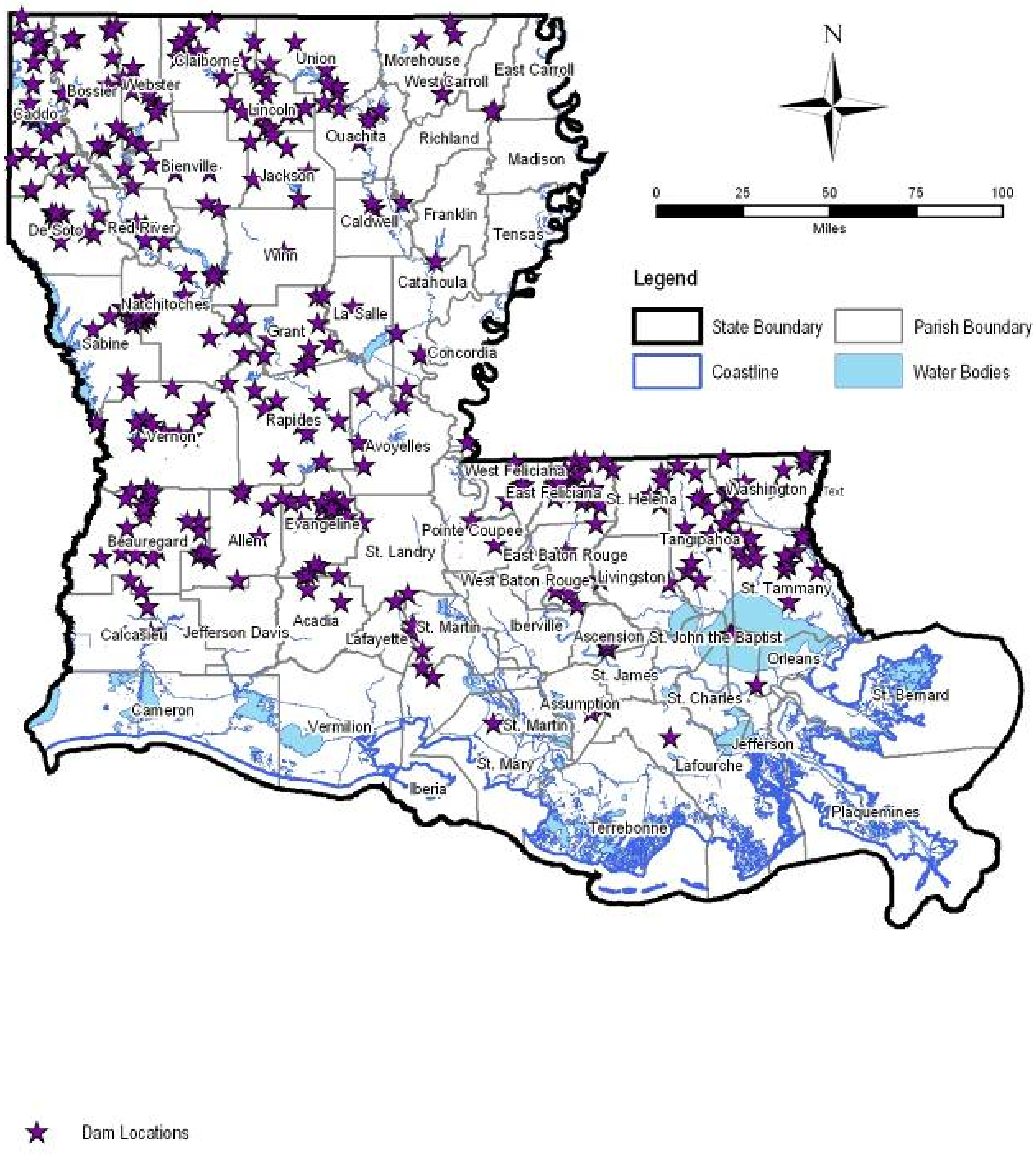
While there are no reports of significant dam failures in Louisiana, the National Performance of Dams Program, a database maintained by Stanford University of dam incidents (events that affect the structural and functional integrity of dams, though not necessarily causing failure and not including ordinary maintenance and repair, vandalism, acts of war, recreational accidents, and sabotage), lists one incident from the fall of 1985. Park managers at the Cotile Lake Dam/Reservoir in Rapides Parish reported seepage due to sand and gravel deposits that displaced concrete slabs. There was no dam failure or controlled breach reported in this incident.

Levees have been overtopped or breached during flood events and non-flood events. A section of levee along the Mississippi River near Marrero failed in a non-flood-related event. The causes this levee's failure included scouring and erosion of sand from the toe of the river bank, which created an over-steepened slope and resultant instability of the upper bank. Severe scour at the toe resulted as the channel bottom deepened through the sandy substratum. Flow failure in the sands then led to loss of the upper bank. Thus, the location of the failure was controlled by the nature of the geologic deposits beneath the levee, combined with progressive deepening of the river channel at that location.

The amount of water impounded, and the density, type, and value of development downstream determine the potential severity of dam failure. In Louisiana, there are 15 high hazard potential, 63 significant hazard potential, and 287 low hazard potential dams.

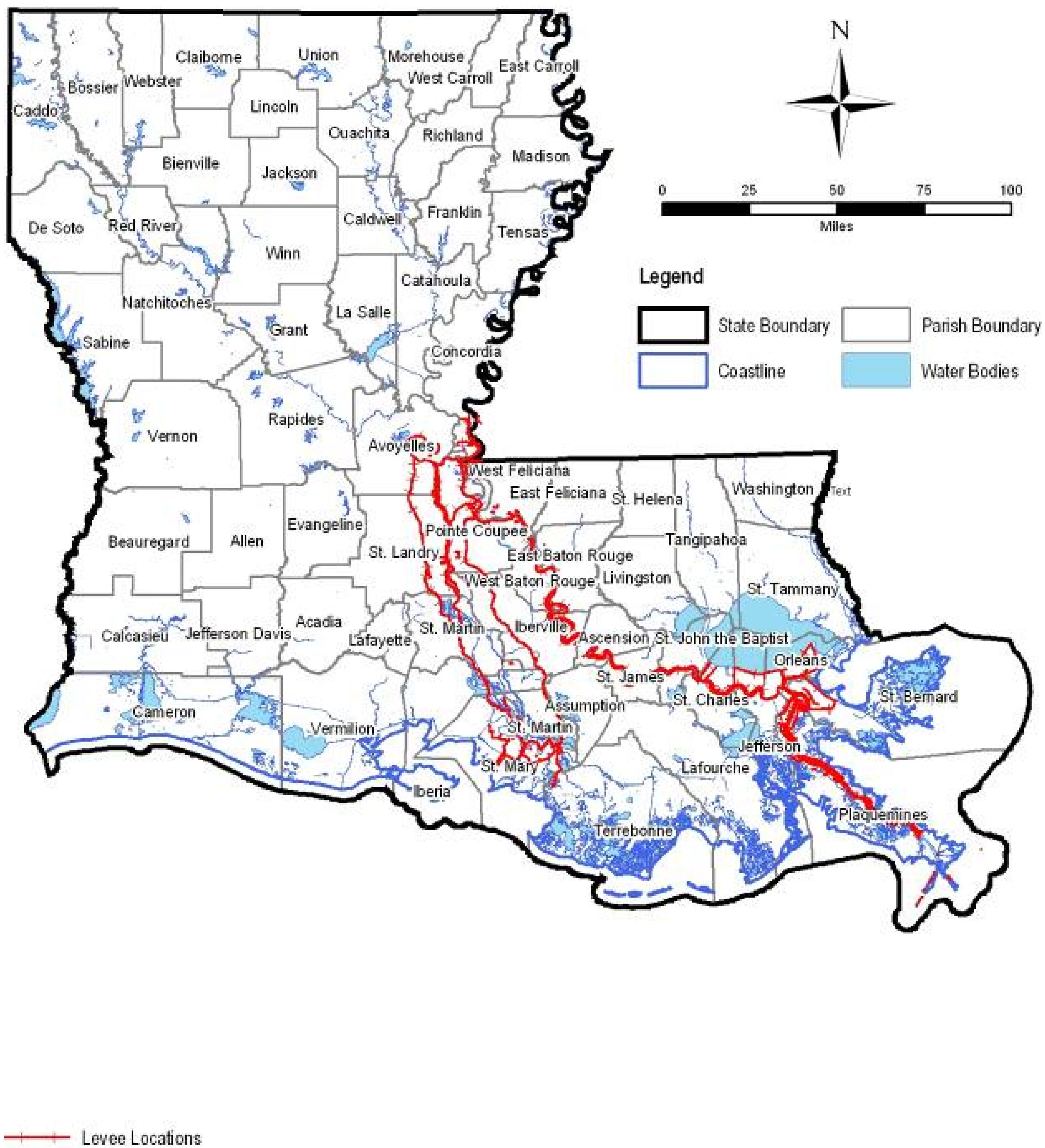
Due to the high potential for significant personal injury and property damage for the State, this hazard included in the risk assessments and addressed in the Mitigation Action Plan.

Map 4-12: Hazard Profile - Dam Failure



Source: U.S. Army Corp of Engineers National Inventory of Dams

Map 4-13: Hazard Profile - Levee Failure



Source: U.S. Army Corp of Engineers

Hazardous Material Incident

Hazardous materials hazards are technological (meaning non-natural hazards created or influenced by humans) events that involve large-scale accidental or intentional releases of chemical, biological, or radiological (nuclear) materials. Hazardous materials events generally involve incidents at fixed-site facilities (see Map 4-14) that manufacture, store, process, or otherwise handle hazardous materials or along transportation routes like major highways, railways, navigable waterways, and pipelines.

Southern Louisiana between New Orleans and Baton Rouge is commonly known as the "chemical corridor" because of its heavy concentration of petrochemical manufacturing facilities sited along highways, railways, and navigable waterways. Map 4-15, which illustrates the number of hazardous material spills per square mile, reflects this fact as one of the areas of the State with the highest "spill density" corresponds to this corridor. As of 2000, the State of Louisiana had 369 fixed-site facilities that filed Toxic Release Inventory reports with the EPA, the agency that monitors the manufacture, disposal, transportation, and releases of hazardous materials. Louisiana ranked 11th in the nation for the number of pounds of on- and off-site releases from these facilities (154,522,635 pounds) and first in the nation for the number of pounds of production-related waste managed (9,416,598,055 pounds).

In addition to chemical production facilities, there are three nuclear facilities with Emergency Planning Zones - the 10-mile Critical Risk Zone and the 50-mile Ingestion Pathway Zone - that include parts of the State of Louisiana, the Grand Gulf Nuclear facility, located in Mississippi, and the River Bend and W-3 nuclear facilities within the Louisiana State boundary. Areas within the Critical Risk Zone are at risk from immediate exposure to accidental radiological releases, and those within the Ingestion Pathway Zone are at risk from air- or water-borne contamination.

While the State has thousands of accidental releases each year, most damaging effects are limited by the insignificant size of the accident and the timeliness of appropriate emergency response. However, some spills and other accidental releases have been of a size sufficient enough to present a danger to nearby populations or the environment.

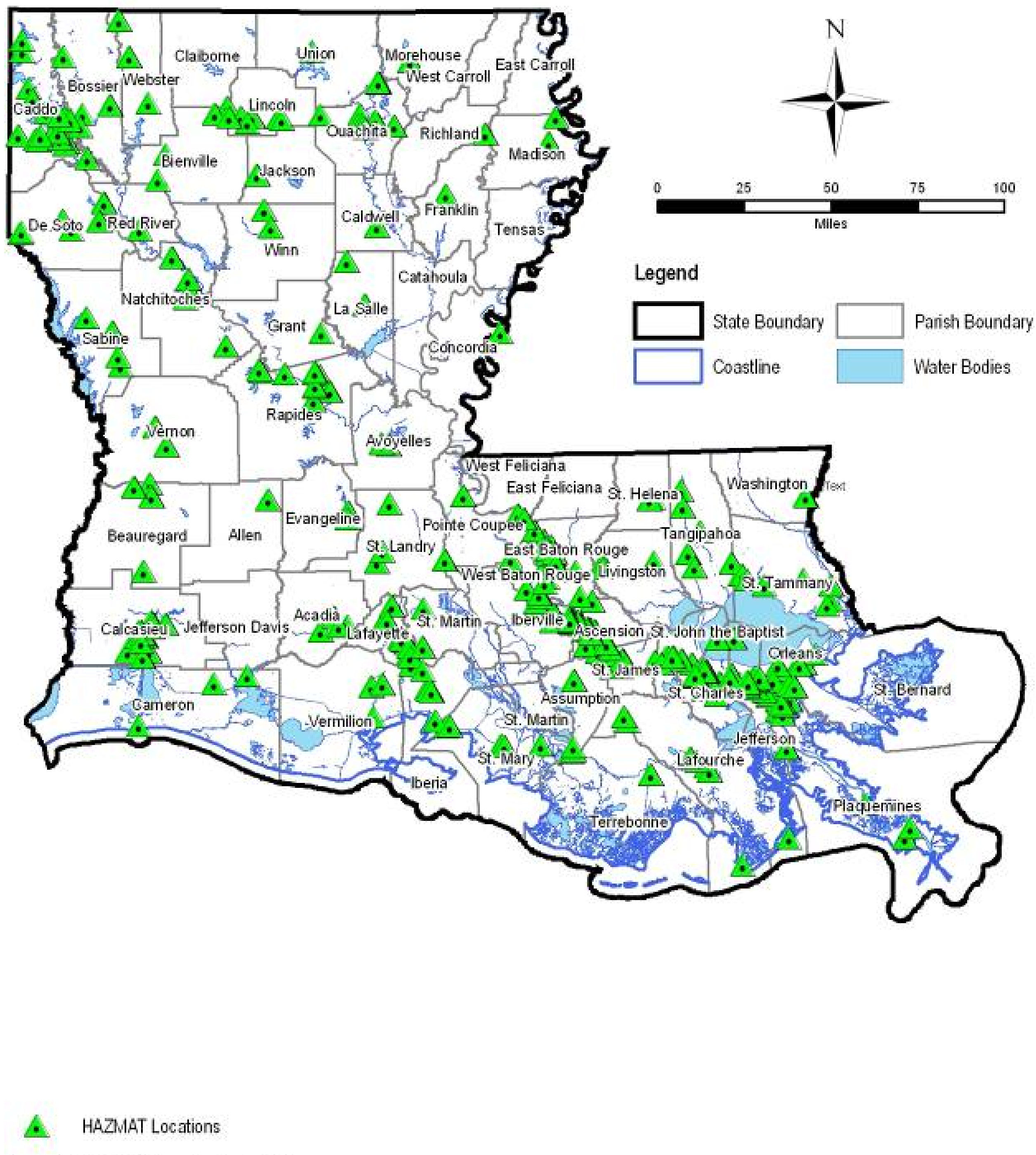
On average, the State of Louisiana receives about 5,000 reports of accidental hazardous materials spills annually. Most accidental releases occur while chemicals are being transported along major highways.

The severity of a hazardous materials release depends upon the type of material released, the amount of the release, and the proximity to populations or sensitive areas like wetlands or waterways. The release of materials can lead to injuries or evacuation of thousands of nearby residents. Nuclear releases are among the most feared of technological hazards because they can cause widespread death or long-term illness to humans and animals and contaminate the environment for decades.

Because the State's "chemical corridor" lies along transportation routes between New Orleans and Baton Rouge in southern Louisiana, scientists and other hazard analysts theorize that hurricane winds, storm surge, or flooding could lead to an accidental release of a hazardous material from a fixed-site or from a transport mode on one of the highways, railroads, or waterways. A professor for the Institute for Environmental Studies at Louisiana State University (LSU) theorizes that airborne debris could breach pipes or tanks, floods could break tanks away from facilities, and floating debris could rupture pipelines. Such releases could lead to widespread contamination of Louisiana's coastline and to inland areas, explosions and fire, and death or injury to humans, plants, and animals.

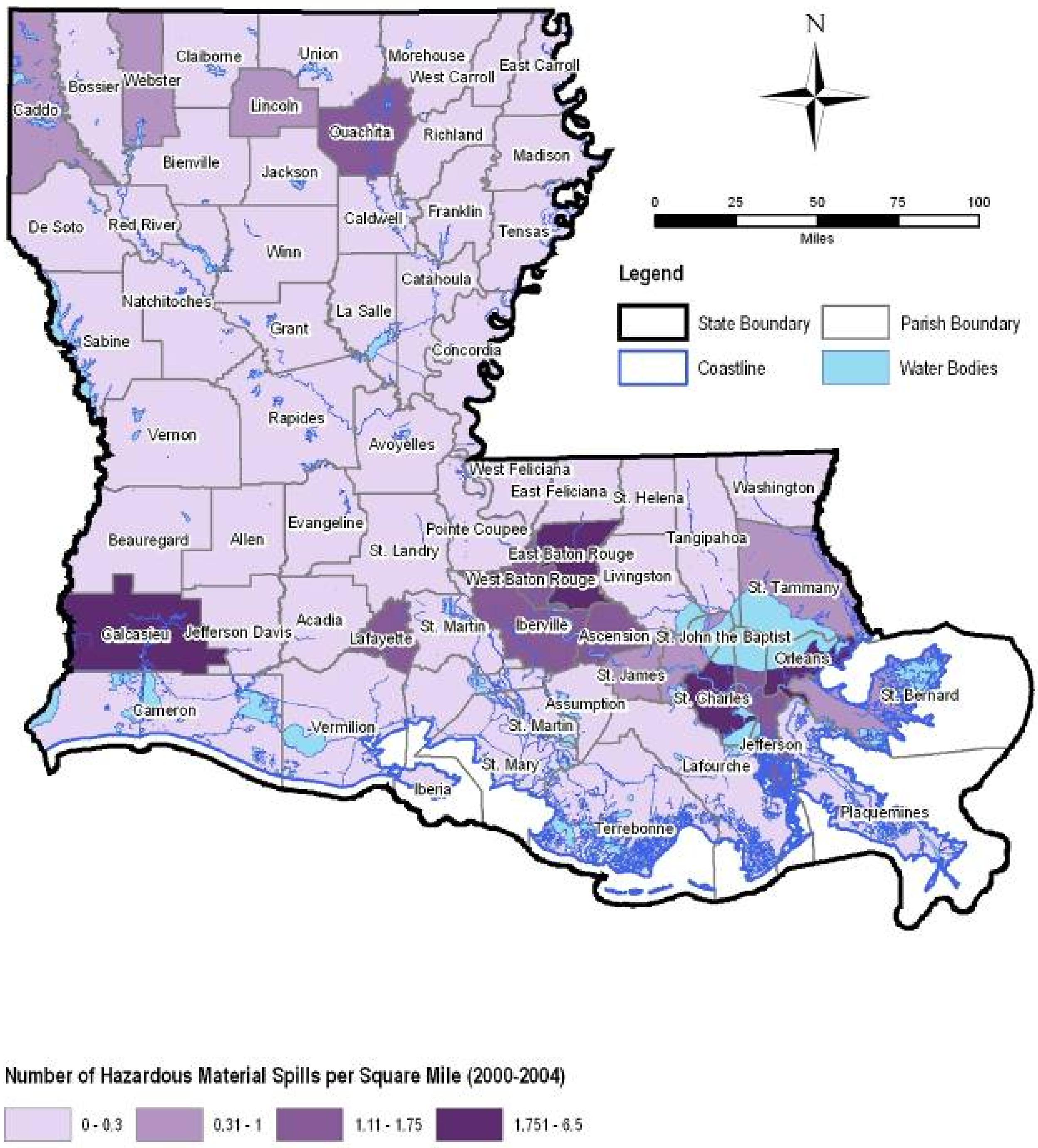
Due to the high potential for significant personal injury due to hazardous material incidents in the State, this hazard included in the risk assessments and addressed in the Mitigation Action Plan.

Map 4-14: Hazard Profile - Hazardous Material Incidents



Source: EPA Toxic Release Inventory 2002

Map 4-15: Hazard Profile - Hazardous Material Incidents



Source: Louisiana DEQ

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Natural Biohazard Incident

Natural biohazards involve the rapid spread of serious, infectious diseases to humans, and can involve acute and chronic infection, parasitism, and toxic and allergic reactions to plant and animal agents. Diseases are transmitted to humans in many different ways. Many diseases are communicable directly from animal to humans, and some infectious or parasitic diseases are transmitted by parasitic arthropod species (including insects and crustaceans) that act as intermediate hosts or animal carriers. Furthermore, a spectrum of plants and animals produce irritating, toxic, or allergenic substances. Dusts may contain many kinds of allergenic materials, including insect scale, hairs, fecal dust, sawdust, plant pollens, and fungal spores. Some occupations are more likely to expose the worker to natural biohazards, including:

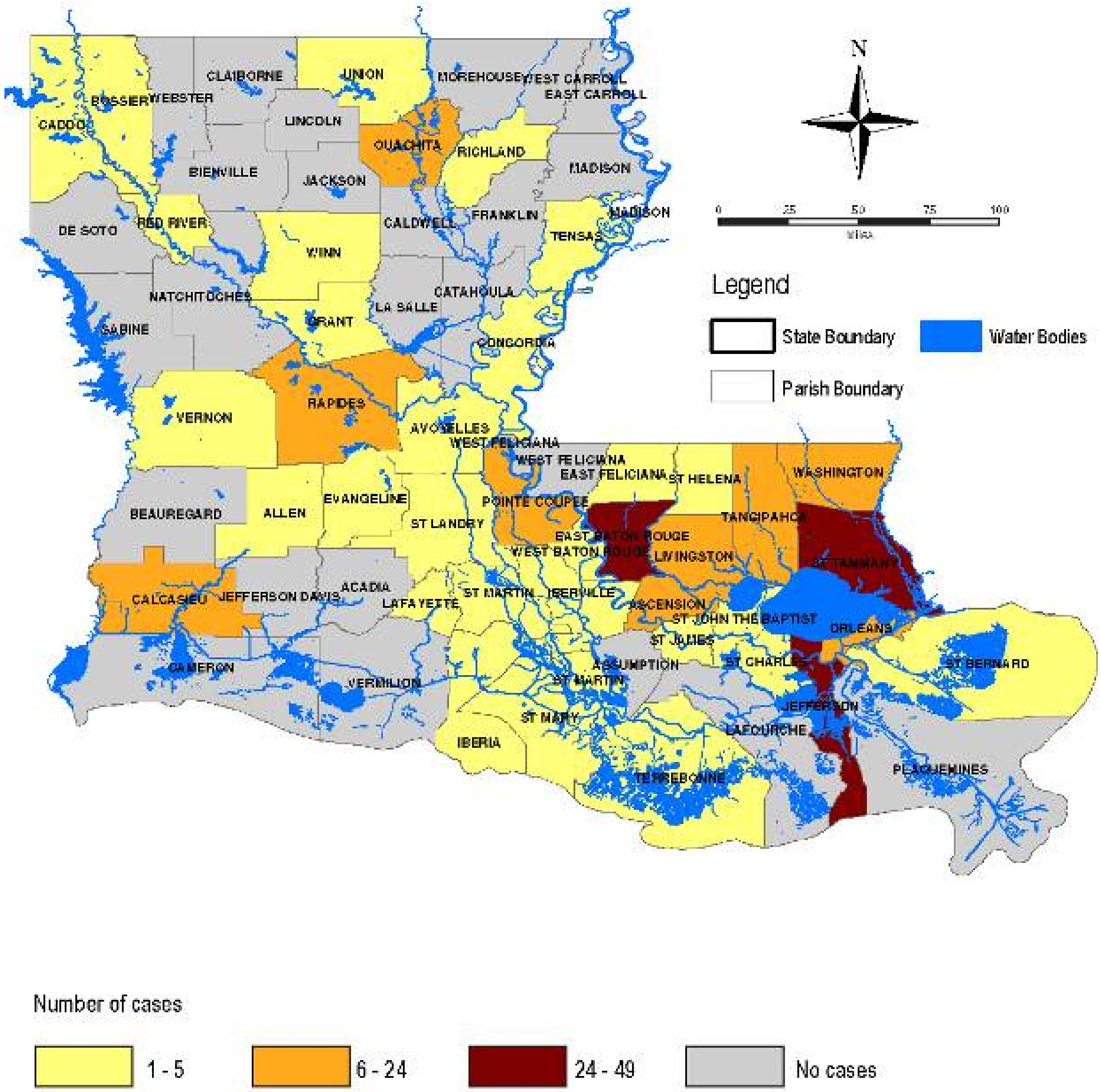
- Plant or animal handlers or those whose jobs cause them to come into contact with animal products;
- Laboratory employees;
- Hospital personnel;
- Employees working with food and/or food processing; and,
- Previously unexposed and susceptible individuals who travel and/or work in new environments that may increase their risk of contracting endemic diseases.

Louisiana public health officials also track emerging diseases like West Nile and severe acute respiratory syndrome (SARS). West Nile virus, which has only been evident in the U.S. since 1999, is a mosquito-borne pathogen that can cause encephalitis or brain infection and occurs in the late summer or early fall. Mosquitoes acquire the virus from birds and pass it on to other birds, animals, and humans. On the other hand, SARS, a flu-like viral disease that emerged in 2003, has spread throughout the world by travelers in close contact with infected people. The disease, which first emerged in Asia, has infected nearly 2800 people worldwide (as of April 10, 2003) and 154 people in the U.S. No cases have been reported in Louisiana.

Diseases that troubled Louisiana included yellow fever, smallpox, cholera, dysentery, malaria, mange, scurvy, yaws, Hansen's disease, and venereal diseases. The most serious epidemics developed from yellow fever, cholera, malaria and smallpox. Yellow fever, a disease with origins in Africa, was the most deadly, especially to Europeans, and killed as much as 60 percent of those who contracted the disease. In 1853, the worst epidemic year, 8000 people -- 1 out of every 15—died of yellow fever in New Orleans. The last major yellow fever epidemic in Louisiana occurred in 1905, five years after scientists discovered that mosquitoes carried the disease.

While epidemics the size and scope of the yellow fever epidemics of the eighteenth and nineteenth centuries are unlikely today, Louisiana experienced in recent decades the impact of several emergent diseases, particularly West Nile virus. According to the Centers for Disease Control and Prevention (CDC), in 2002, Louisiana had 330 cases of laboratory-positive human cases of West Nile virus and 24 deaths from the disease, making Louisiana the 4th leading state for cases and for deaths. Map 4-16 shows the spread of the virus around the State in 2002.

Map 4-16: Hazard Profile - West Nile Disease



Source: Center for Disease Control (CDC), 2002.

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